Unit 1 Habitable Worlds

Learning objectives:

- 3 things needed for life
- 2 Types of organisms (producers and consumers)
- Most important elements for life

Habitable World Video Notes

Essential question:

What makes a good environment for life?

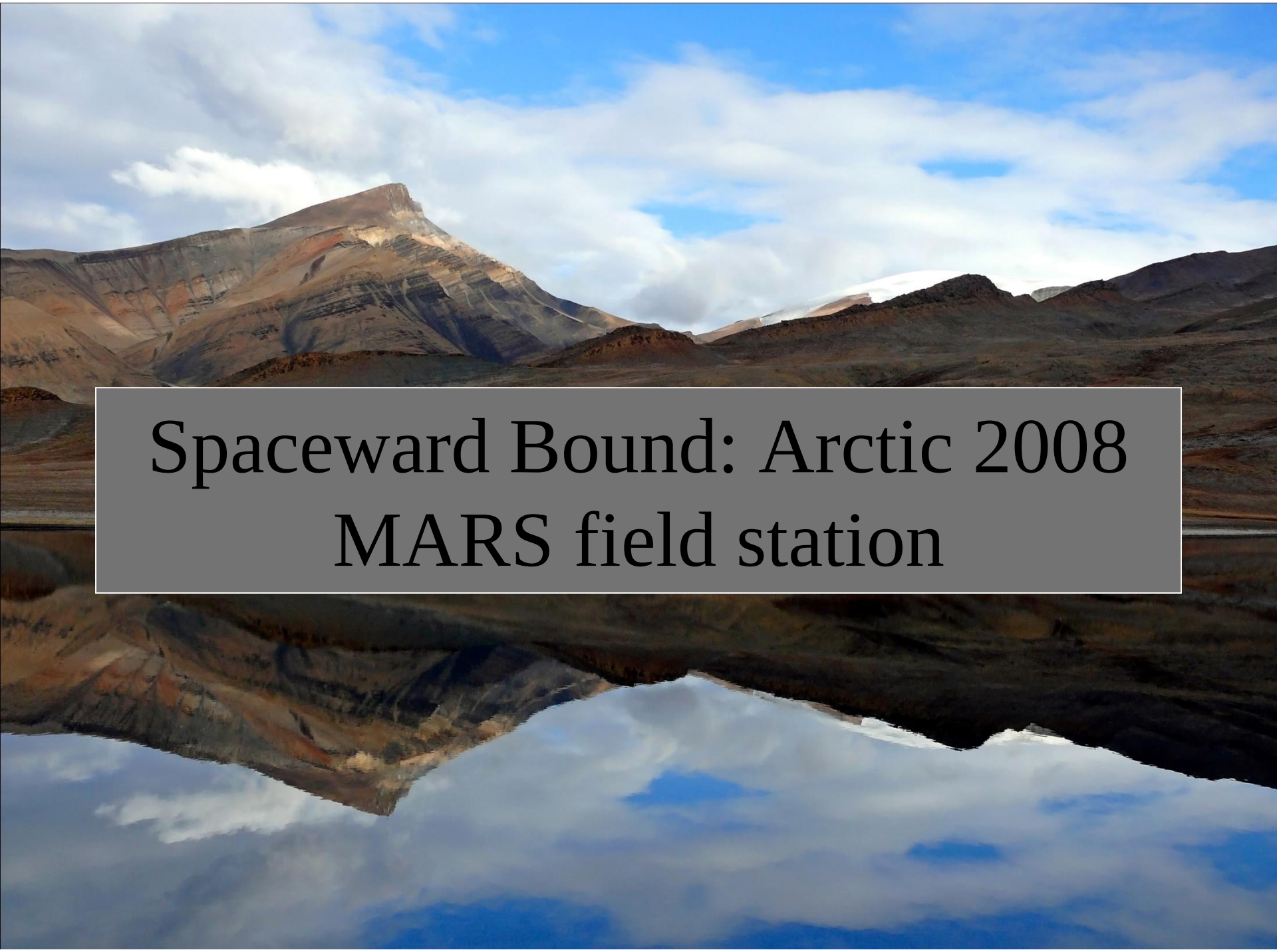
Define habitable:

http://www.youtube.com/watch?v=p4OqZtojqUQ&feature=plcp

Habitable = Livable =
Ability to support life

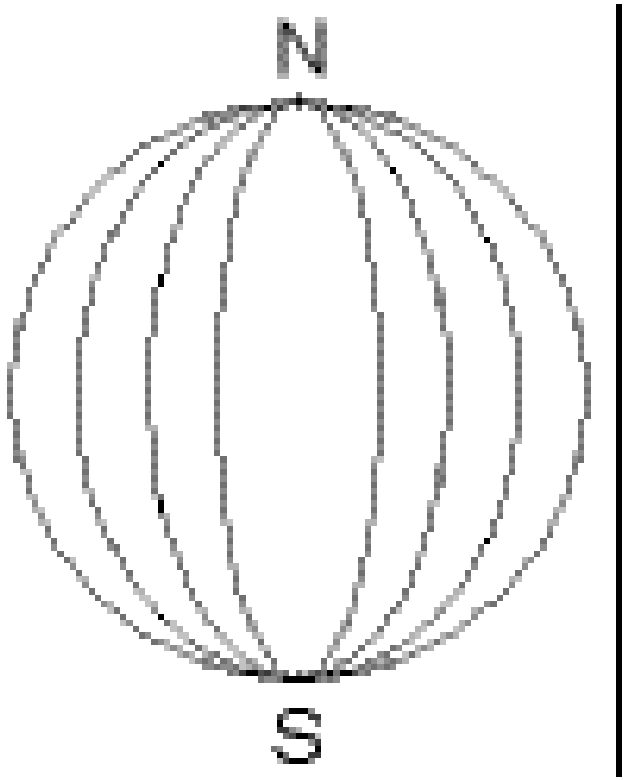
Living Things Require

- Liquid water
- Building blocks =Nutrients (CHNOPS)
- Energy Source

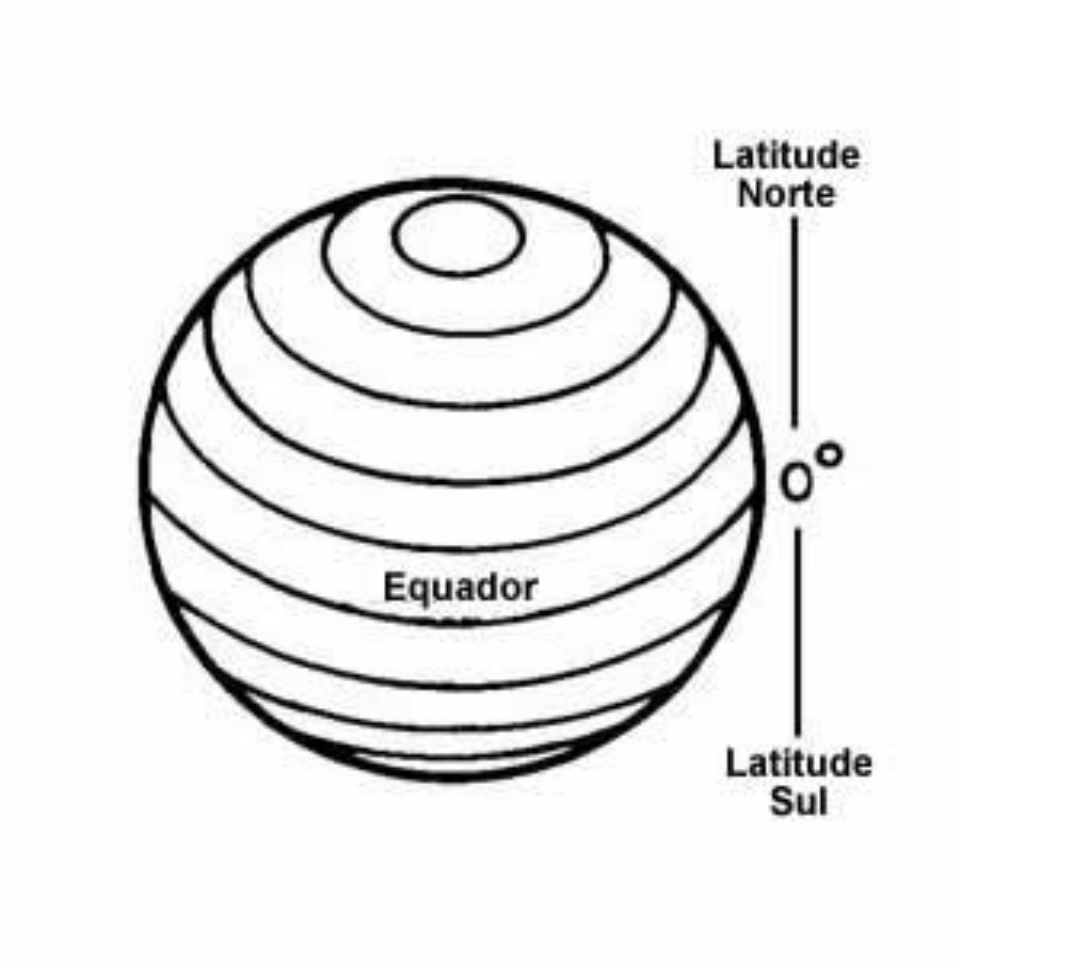


Spaceward Bound: Arctic 2008 MARS field station

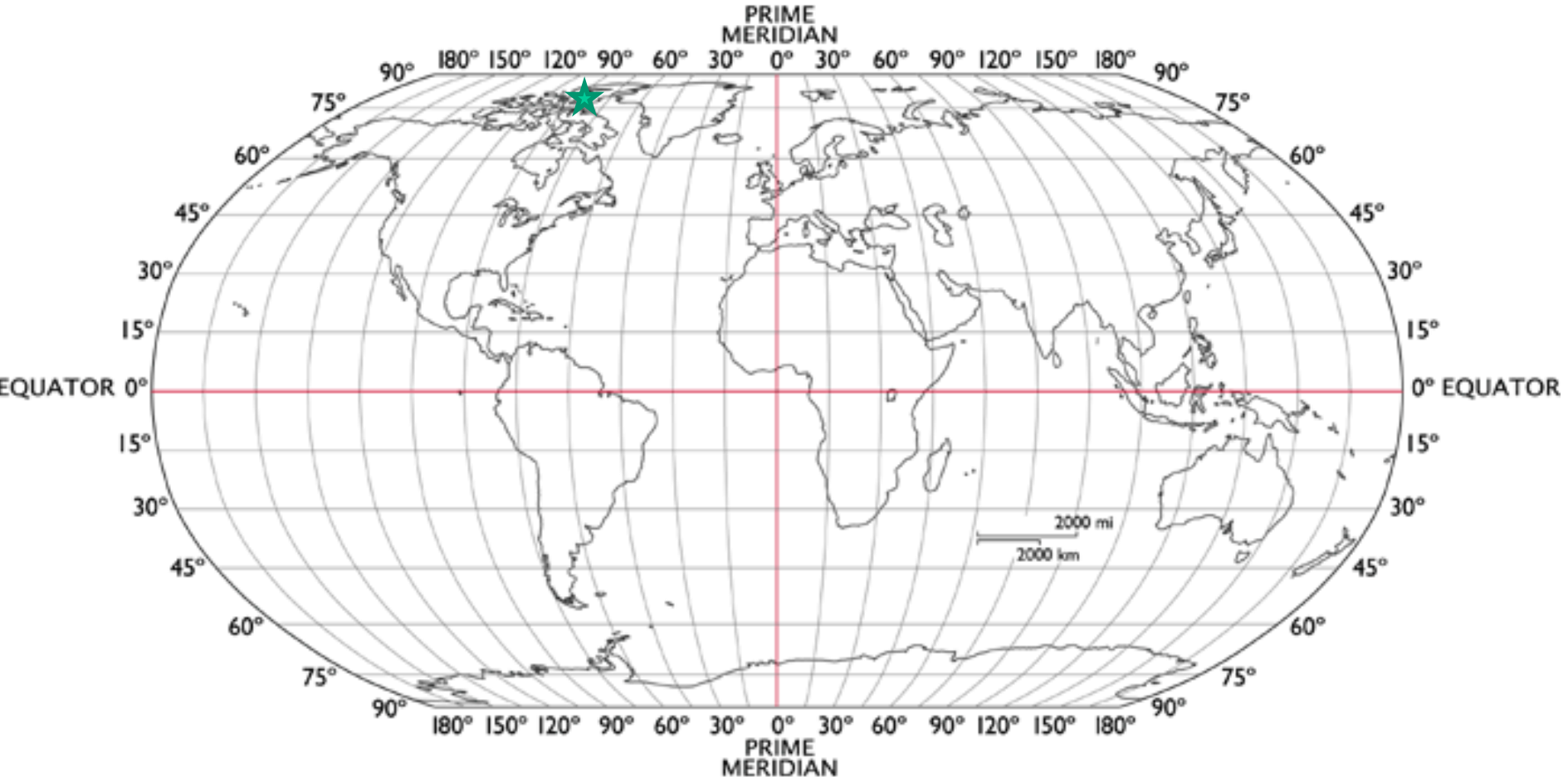
Draw lines of longitude on the globe below



Draw lines of latitude on the globe in your notes



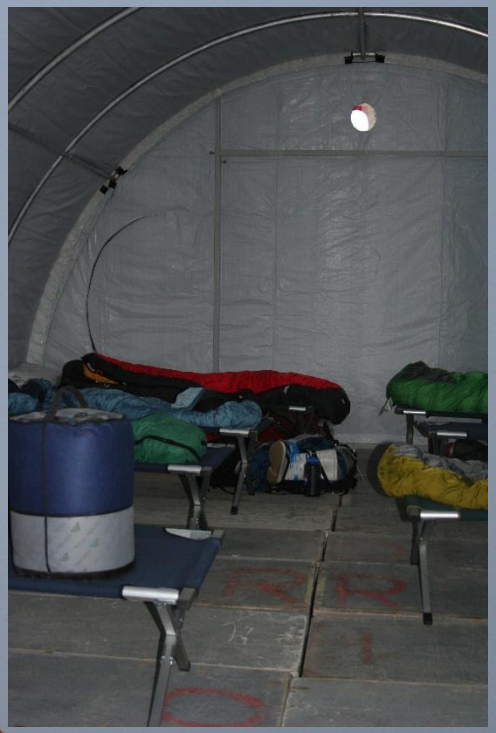
Put a star at 80°N 90°W



McGill Arctic Research Station

Getting there

The Shelf



Twin Otter Transport

Summer in the Arctic


FORESTER
CASIO
19

Time Lapse photos of Sun

noon midnight

1. Why does the sun look like it moves across the sky?

2. Why is it still light out in the Arctic at midnight?

3. Predict what happens to daylight in the winter on Axel?


Welcome to Axel

Bunkhouse / Lab

Kitchen on Colour Lake

Meet the Team

The Mission

- Prepare for human exploration on Mars by studying life in extreme environments on Earth

Journey to Mars

Building on decades of robotic exploration, we're working to send humans to Mars in the 2030s. First, the Space Launch System and Orion will carry astronauts into the proving ground of deep space, including a yearlong mission. We'll also conduct a robotic Mars sampling mission, and test techniques for landing on and living on the Red Planet.


MEET AMERICA'S NEW
ASTRONAUTS

Extreme Environments

- Mars = Phoenix rover landing site
  - (-28°F to -100°F)
- Axel = Average temps in February
  - (-31°F to -49°F)

Chris McKay

Planetary Scientist

Space Science Division
NASA Ames Research Center
Expedition Lead

https://www.youtube.com/watch?v=xlIj-BtYWn4 up to 5:00

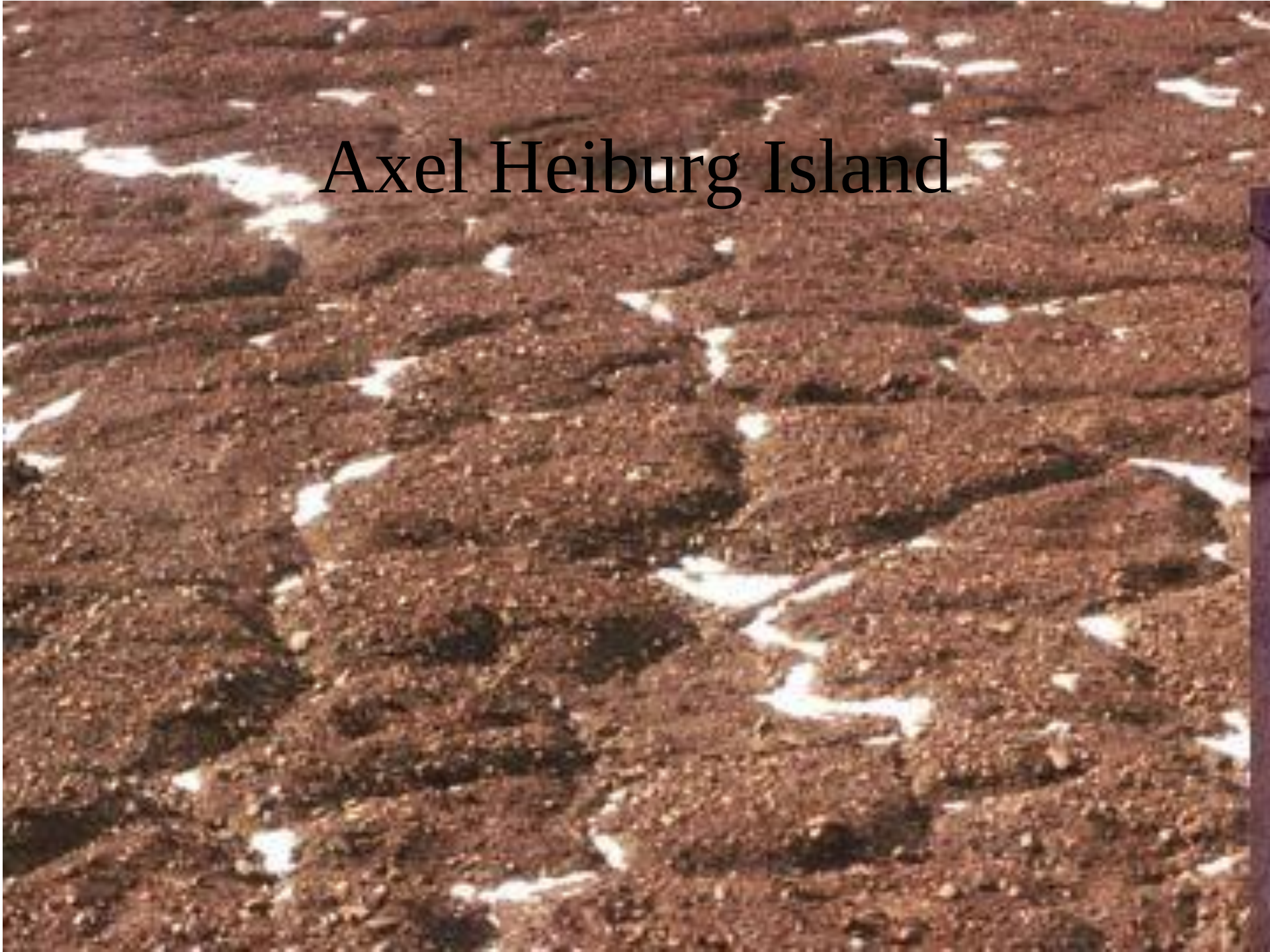
What does life need???

Define metabolism

- All the chemical reactions needed to live
- Required for life

- Ex: eating, digesting, growing

Search for Life on Mars

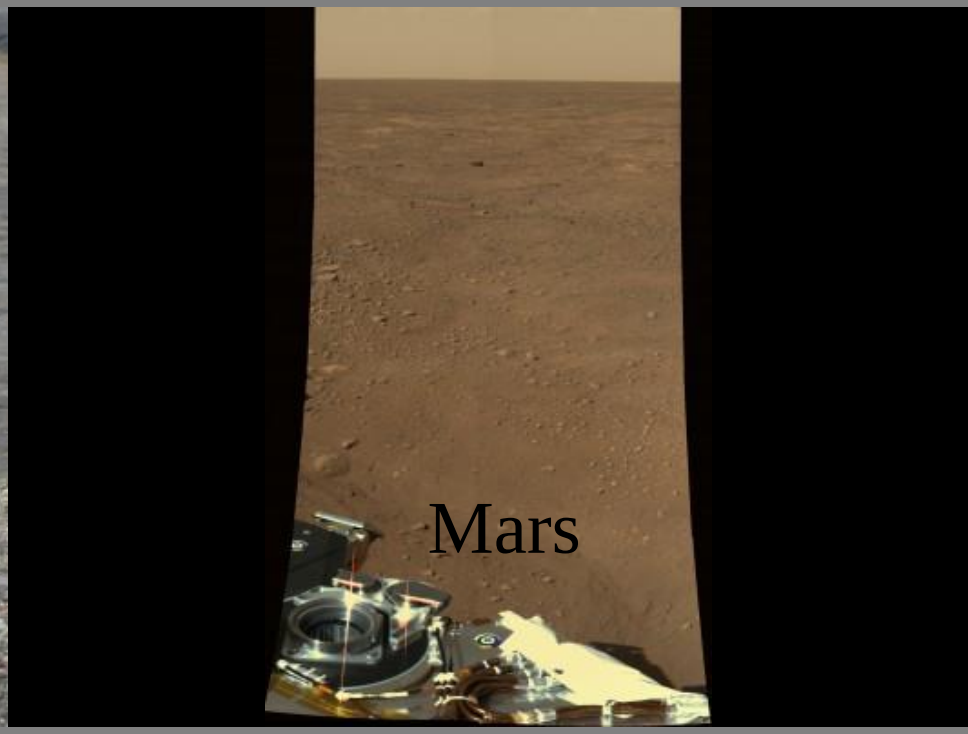

Axel Heiburg Island

Phoenix rover landing site

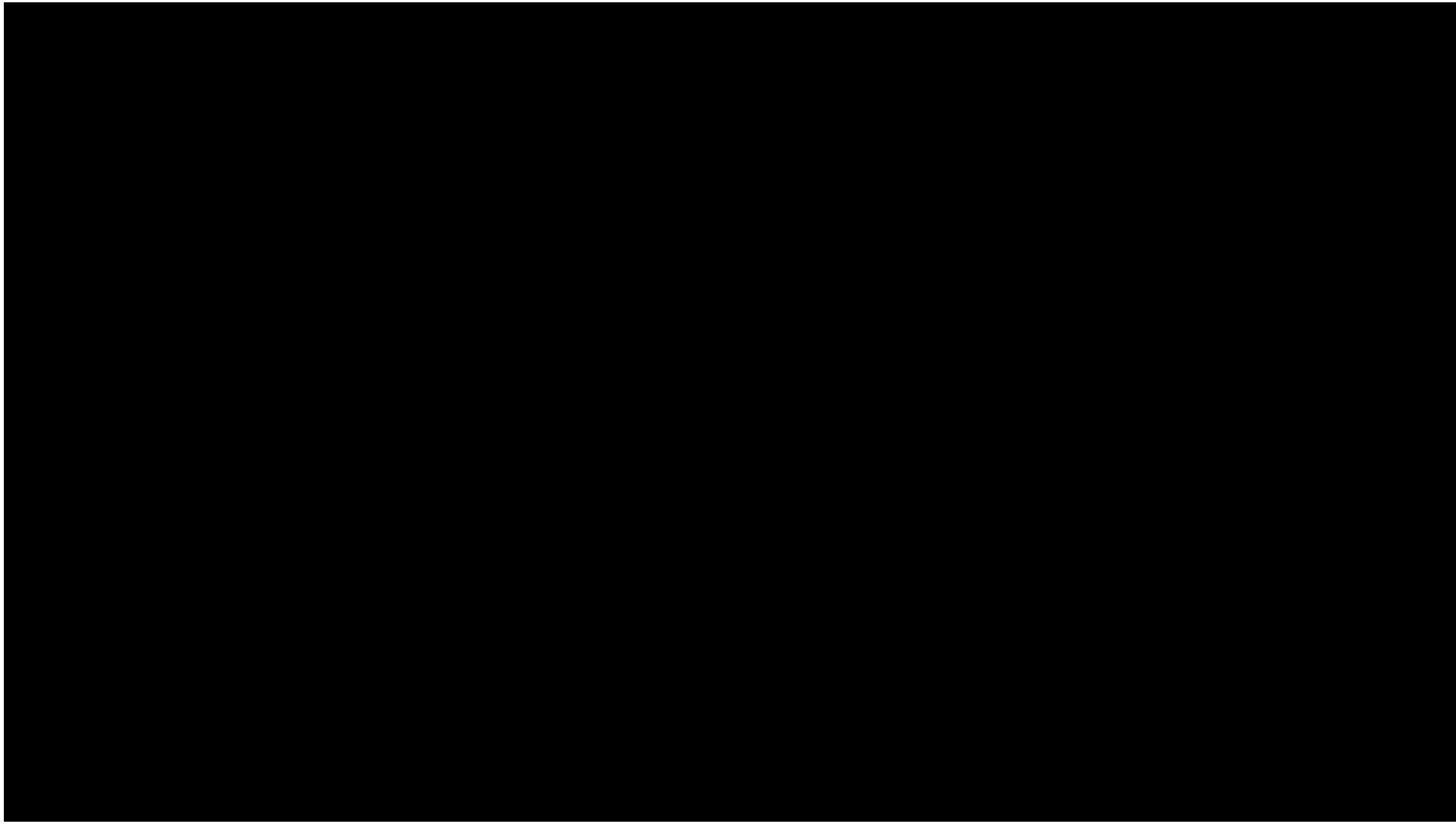
Phoenix landed Sunday 25 May 2008

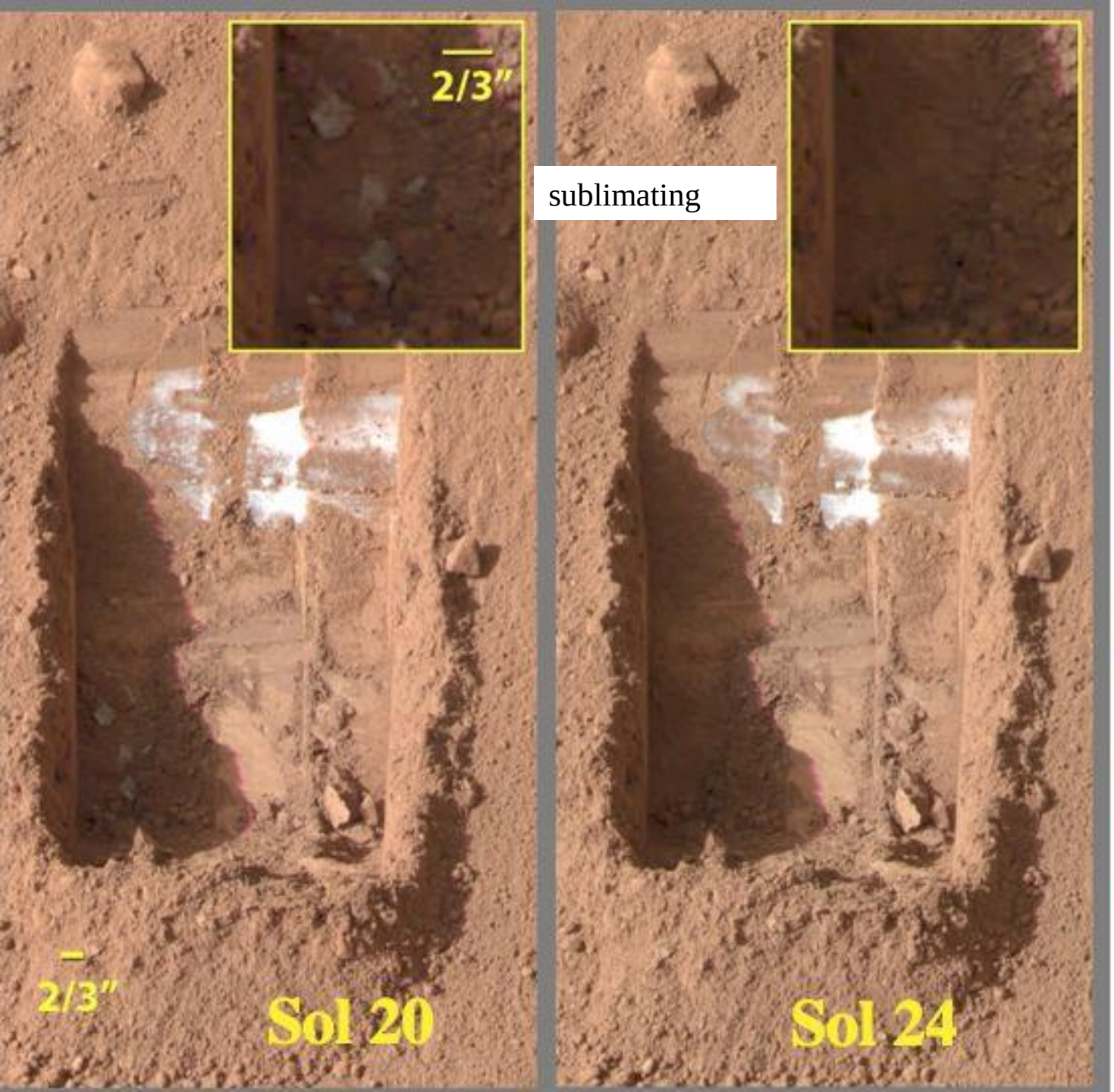
- North polar region of Mars
- Looking for liquid water (essential for life)

Freeze thaw cycles → Polygon patterns in in polar dry deserts



Tribute to Phoenix





sublimating

This is ice!

It is evaporating.

Discrete ice lens like this require a liquid phase to form.

Could the have been a eutectic brine?
Not $CaCl_2$

Search for Life

- 1st find water
- 2nd look for building blocks of life
  - Ex: carbonates, sugars, proteins, fats

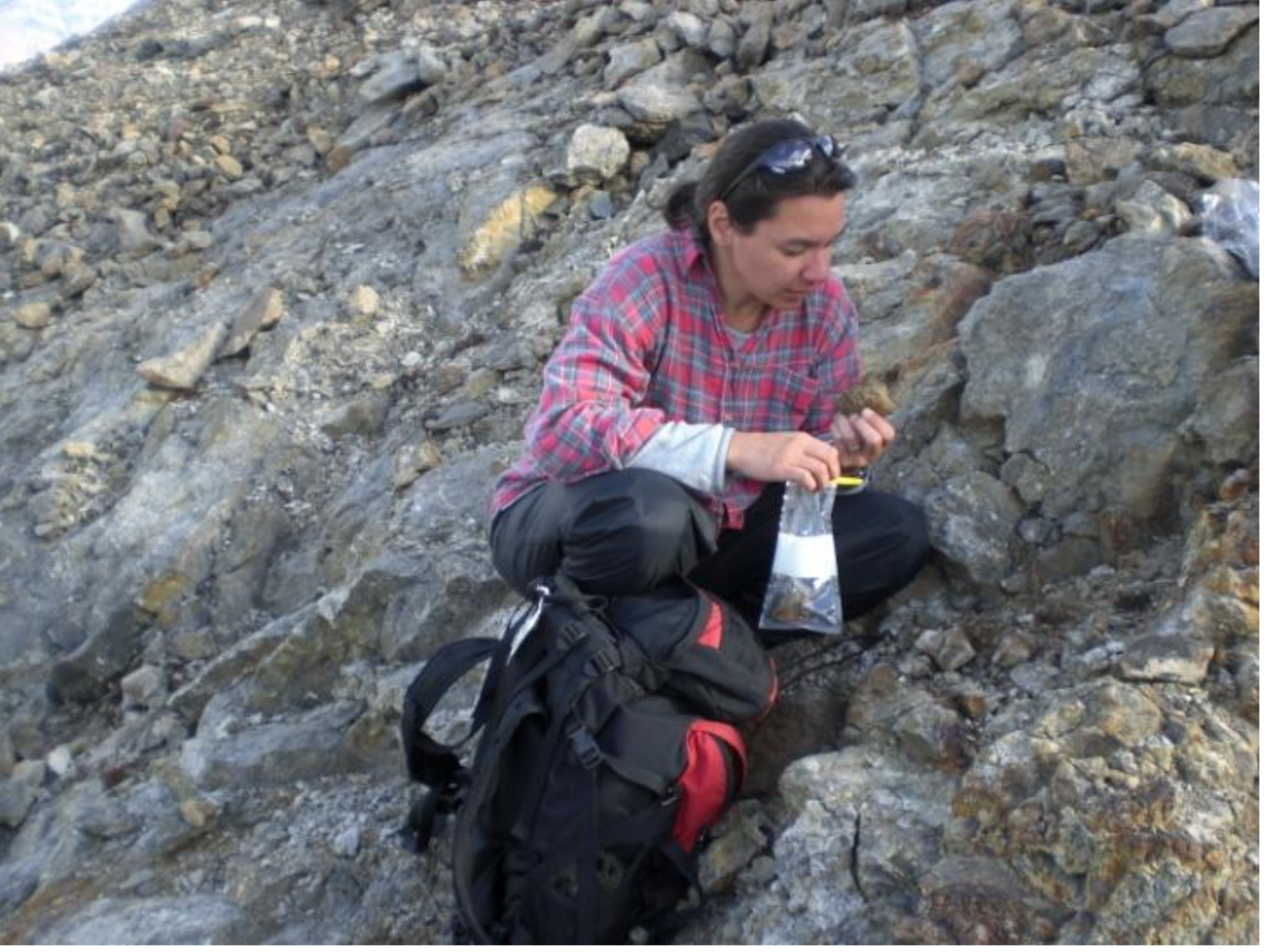
Building blocks of life =

- Carbon atoms connected to hydrogen, oxygen, nitrogen and other elements

- Ex: carbonates, DNA, proteins and sugars

Collecting microbial fossils at Relic Springs

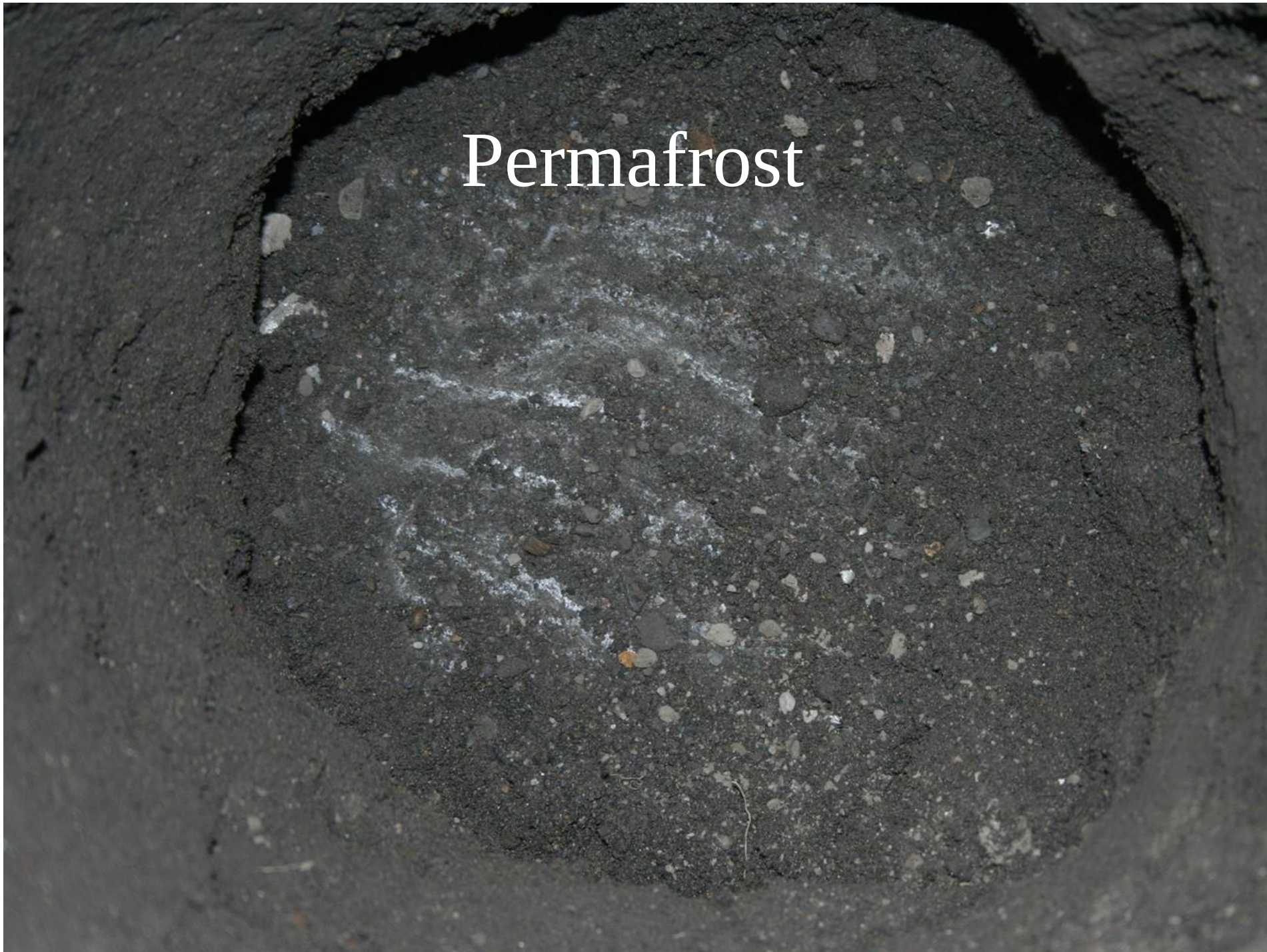

Sharpie



Vinegar test

- Drop rock samples into vinegar.
- If gas bubbles form, then the rock contains carbonates (building blocks of life)

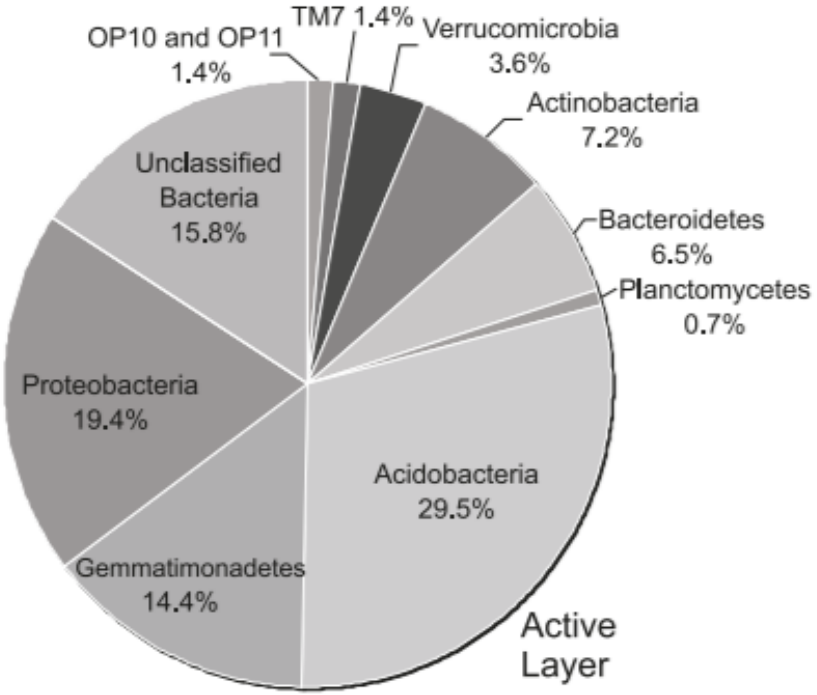
Classifying Life in the Extremes

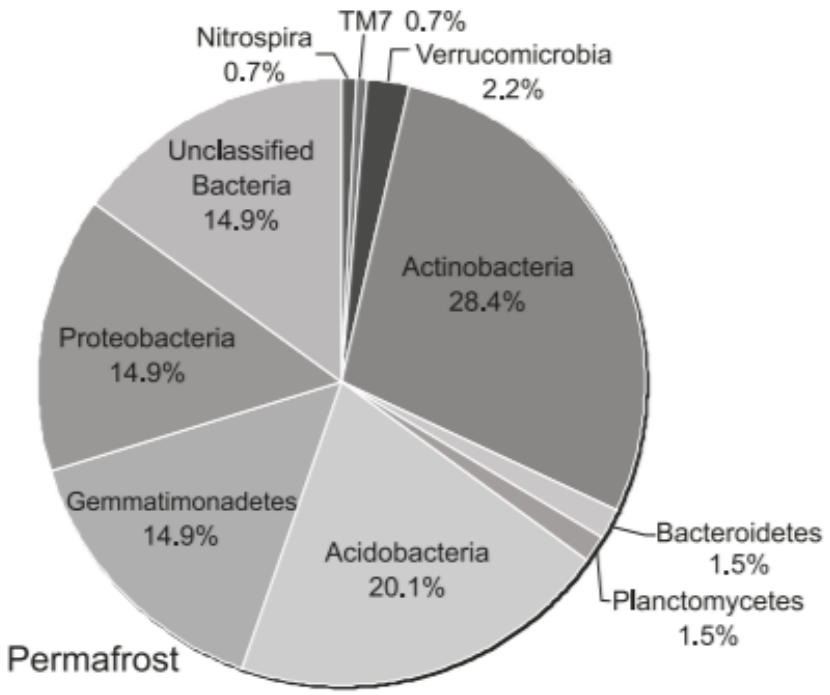

Permafrost

Results

Describe 2 difference between bacteria above and inside permafrost

Fig. 1. Distribution of phyla derived from 16S rRNA bacterial clone sequences in the active layer (left) and permafrost (right), as classified by the Ribosomal Database Project. The percentage corresponds to the total number of sequences in the active layer (n = 139) and permafrost (n = 134).





Above the permafrost

Inside the permafrost

Life in Extreme Cold

http://spacewardboundarctic2008.blogspot.com/

- "*Is there life in Gypsum Springs*" **video questions**
- Why are the rocks grey?
- They're covered in bacteria (biofilms)

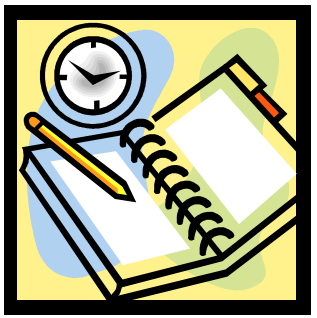
- How do sulfur reducing bacteria survive?
- They use sulfur compounds → metabolism

Science Can Be Fun!!!!

Let Me Help You

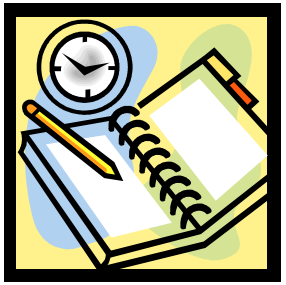
KEY IDEA: Living World Depends on Non-Living World

Notes:



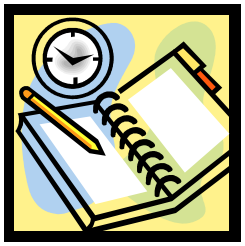
- Living things require
  1. An Energy Source
  2. Liquid Water
  3. Raw Materials / Building Blocks

Energy Source



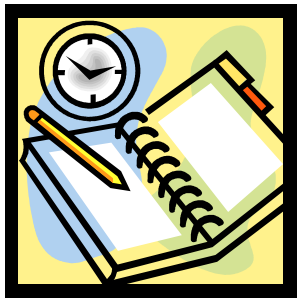
- Producers use light or chemical energy → food
  - (ex: plants)
- Consumers get energy from eating living things
  - (ex: animals and decomposers)

Liquid Water



- Dissolves and moves things
- Helps maintain homeostasis
  - Homeostasis = maintaining balances
    - Balances temperature
    - Balances concentrations of dissolved things

Raw materials



- = nutrients
- Most important elements for life = CHNOPS
  - Carbon, Hydrogen, Nitrogen, Oxygen, Phosphorus, Sulfur

Habitable worlds in our solar system

- Except for Earth each planet and moon has major limitations
- If life exists on any of our planets or their moons it is most likely small and underground
- Europa, Mars, and Titan may have or have had habitable conditions

Quiz Questions

1. List 3 things needed for life
2. Define metabolism
3. Define each and give an example
   - Producer
   - Consumer
4. list the 6 most important elements for life (write them out - not just the symbols)
5. What is homeostasis?

End packet 1

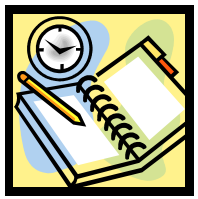
World Populations

4,176,000,000,000,000,000,000,000,000,000	Prokaryotes
10,000,000,000,000,000,000	Insects
6,250,000,000	Humans (as of Sept., 2002)

Just hit 7 billio

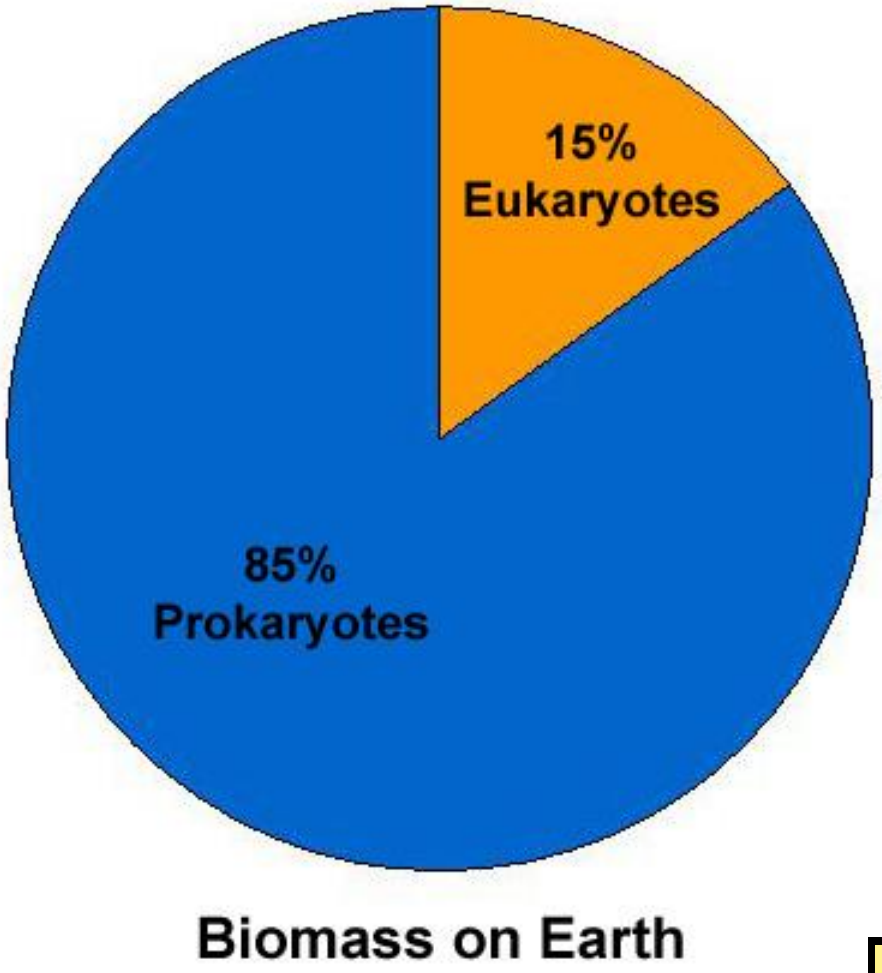
Prokaryotes = simple one celled organsims without a nucleus

Ex: bacteria, blue-green algae



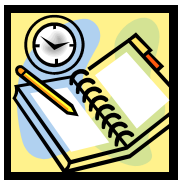
Microbes Rule!

Nine out of ten cells in the human body belong to microbes. Don't let it bug you. We couldn't live without them.



Biomass on Earth

Biomass = <u>living matter</u>



Prokaryotes → Biofilms

Algae

Lichen

Mud

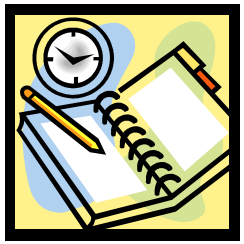
Sink

Rock 1

Rock 2

Rock 3

Biofilms = living layers



- Made of cells
  - Lots of different types
  - Ex: bacteria, fungi, algae, plant matter, and/or microscopic animals
- What do they need in order to survive?
- Liquid water, energy, and nutrients
- Where on earth would you expect to find them?
- moist environments, ocean, lakes and ponds, on foods, rocks, trees, in the human body …..

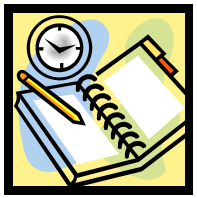
Origin of Life Hypotheses

- Fossil evidence exists of biofilms in ancient rocks

- By studying these rocks scientists hope to learn about early life.

Best hypothesis = earliest life forms on earth were <u>simple – one celled organisms</u>

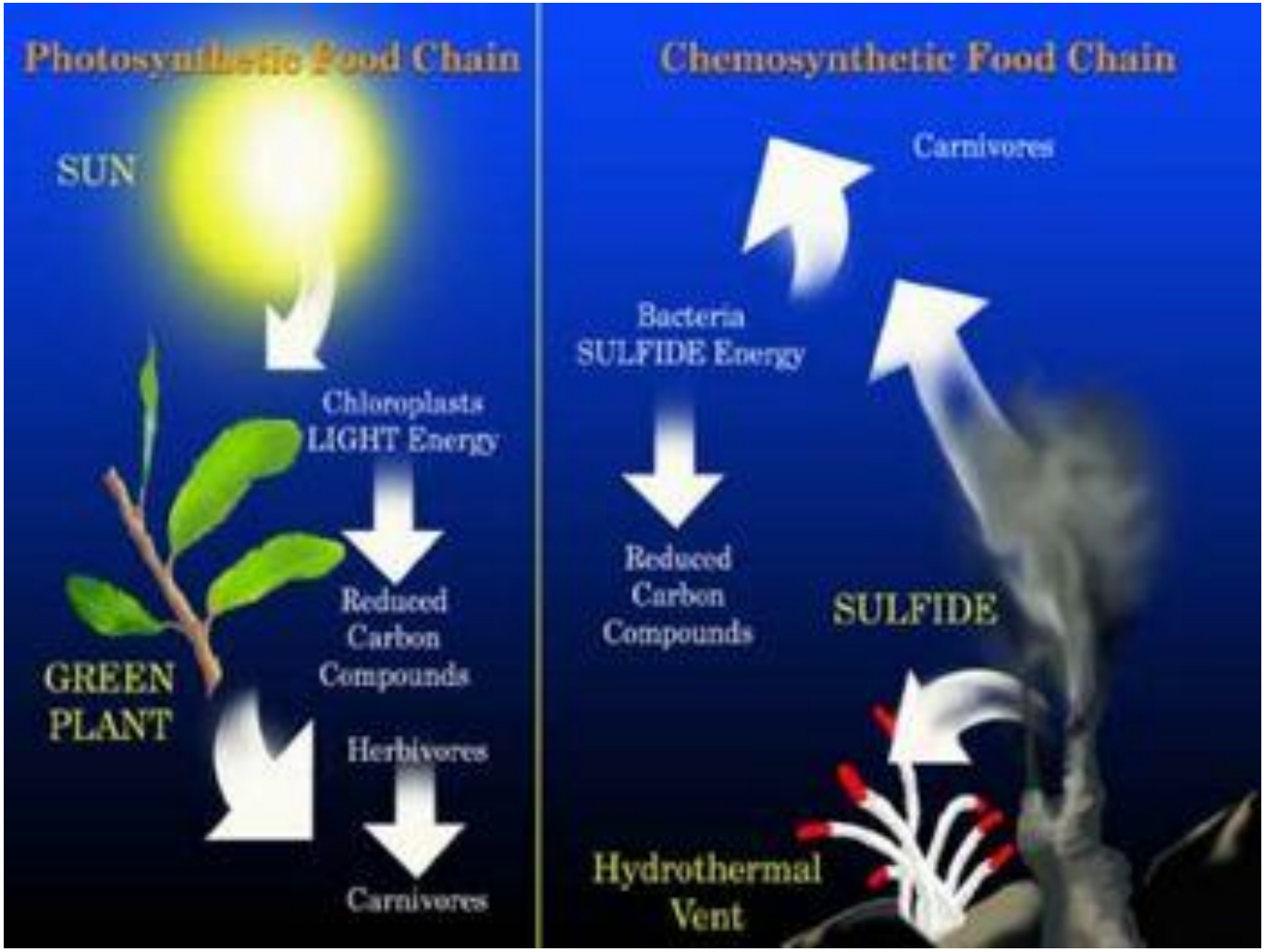
http://www.nvcc.edu/home/cbentley/geoblog/labels/birdies.html



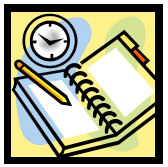
Producers = Autotrophs

producers convert inorganic → organic

produce energy molecules



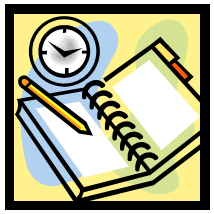
Interdependence = Organisms depend on each other → survive

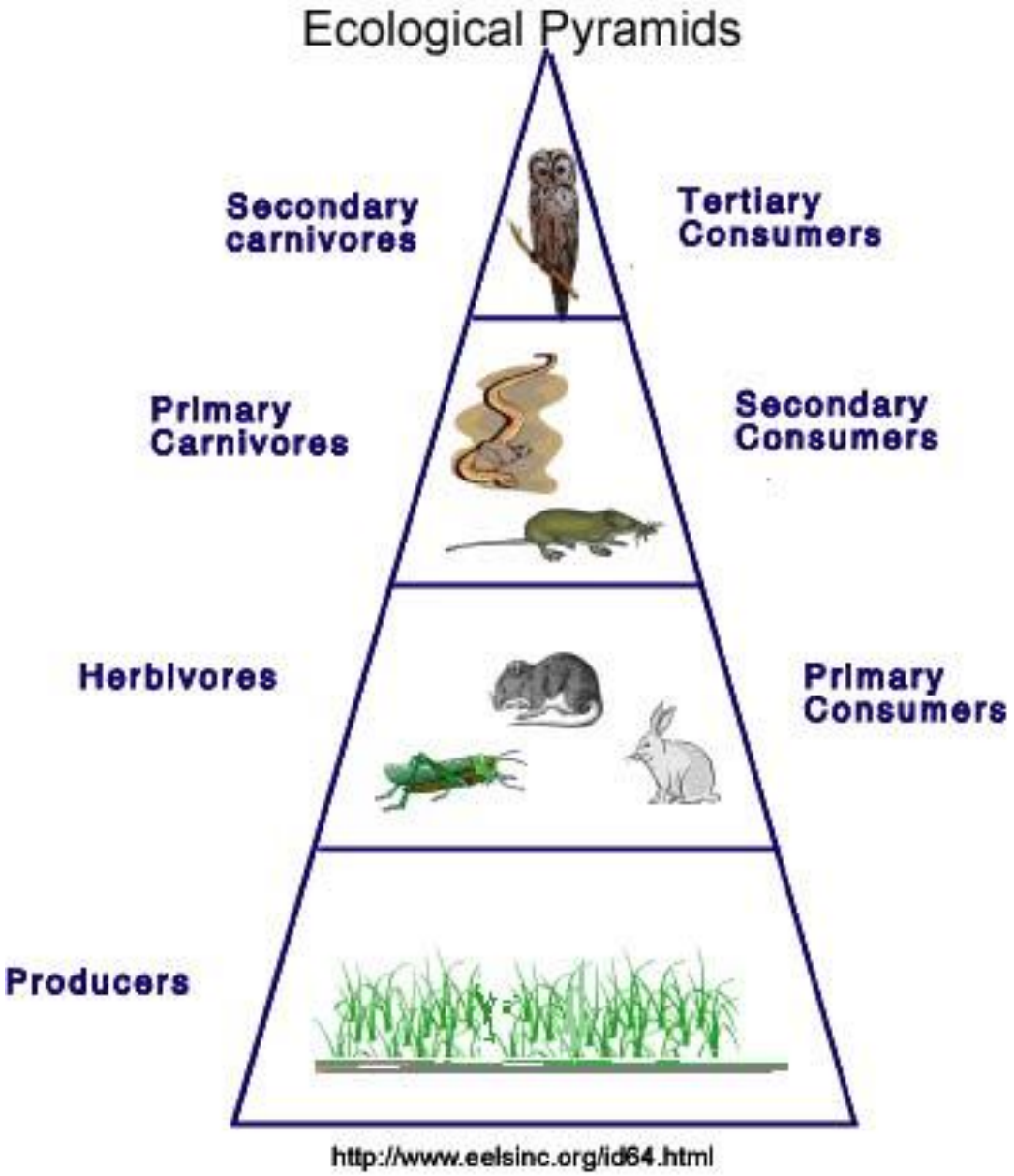


- Heterotrophs = consumers (cannot make their own food)
- Decomposers = heterotrophs → recycle nutrients for plants
- Ex: bacteria and fungi
- Consumers need producers for food
- Producers need consumers to recycle nutrients

Interdependence

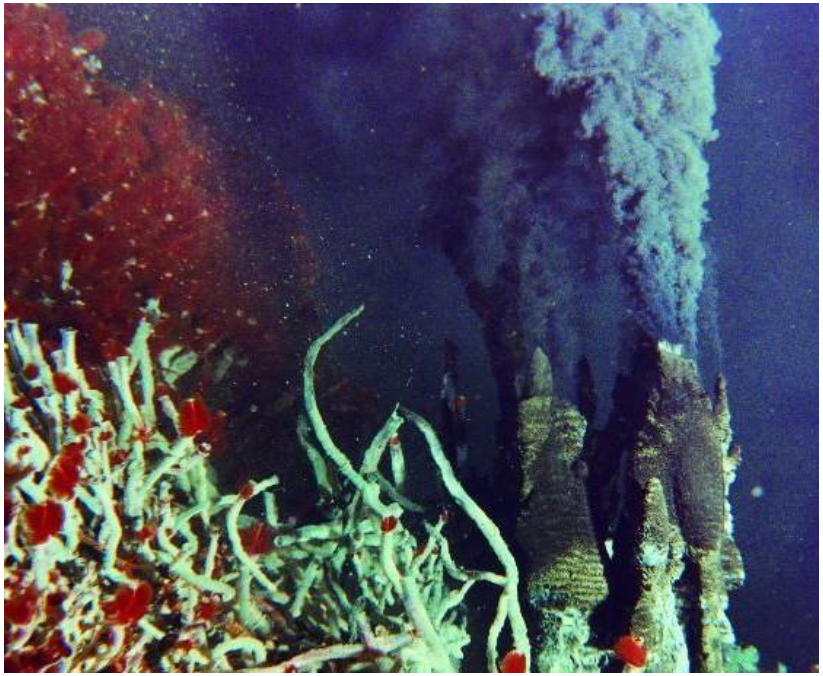
Plant producers form base of most food chains





Give an example of a food chain

Bacterial producers form base of deep ocean communities



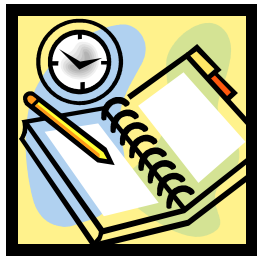
http://www.dailygalaxy.com/photos/uncategorized/2008/08/04/black_smoker.jpg

http://www.waterencyclopedia.com/La-Mi/Life-in-Extreme-Water-Environments.html

Meet Dale Andersen

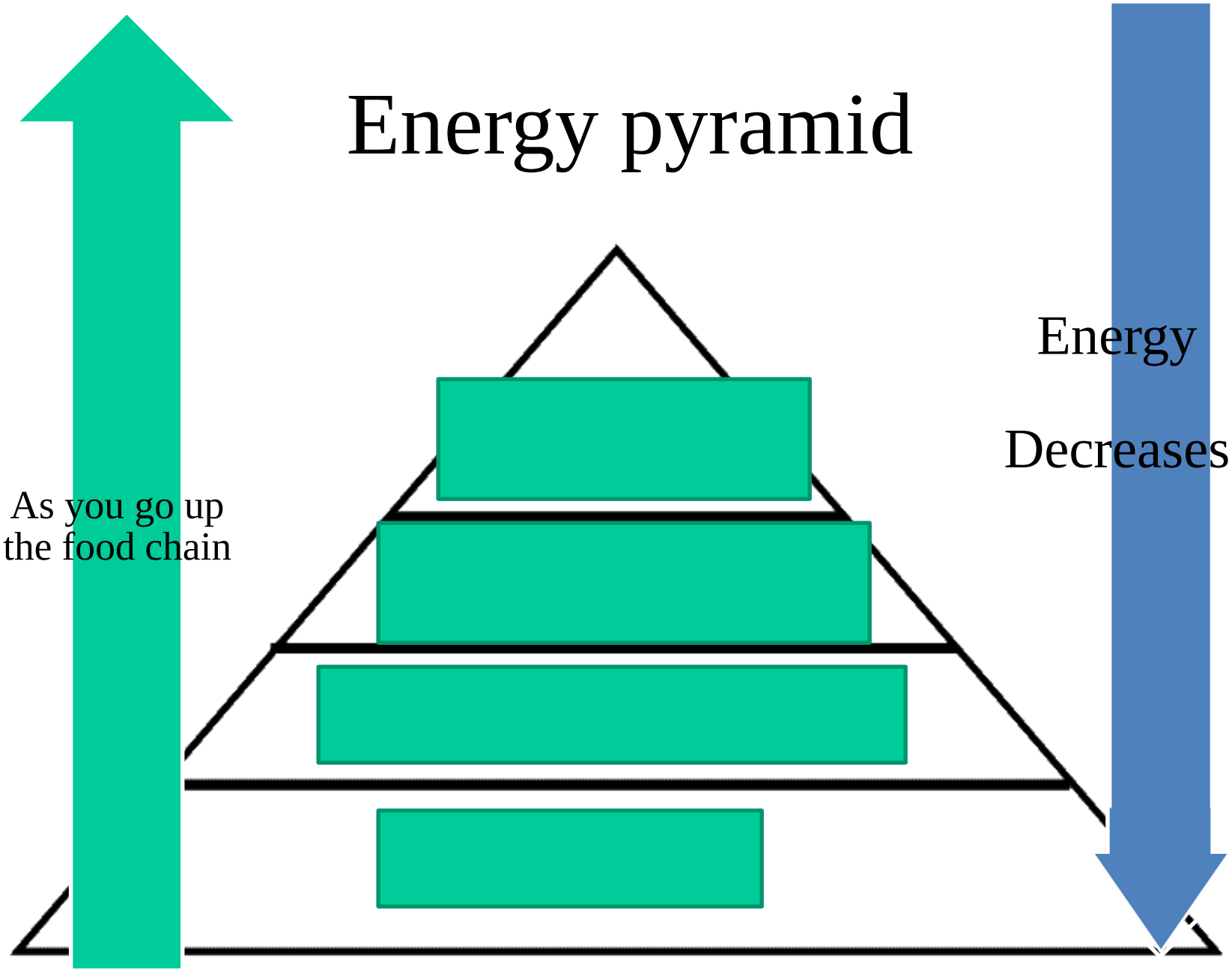
- https://www.youtube.com/watch?v=qs2hUZP-6Bo

Types of Consumers



- Herbivores = plant eaters (primary consumers only)
- Carnivores = meat eaters (secondary consumers)
- Omnivores = eat both (can be primary and secondary consumers)
- Decomposers = recycle nutrients

Energy pyramid

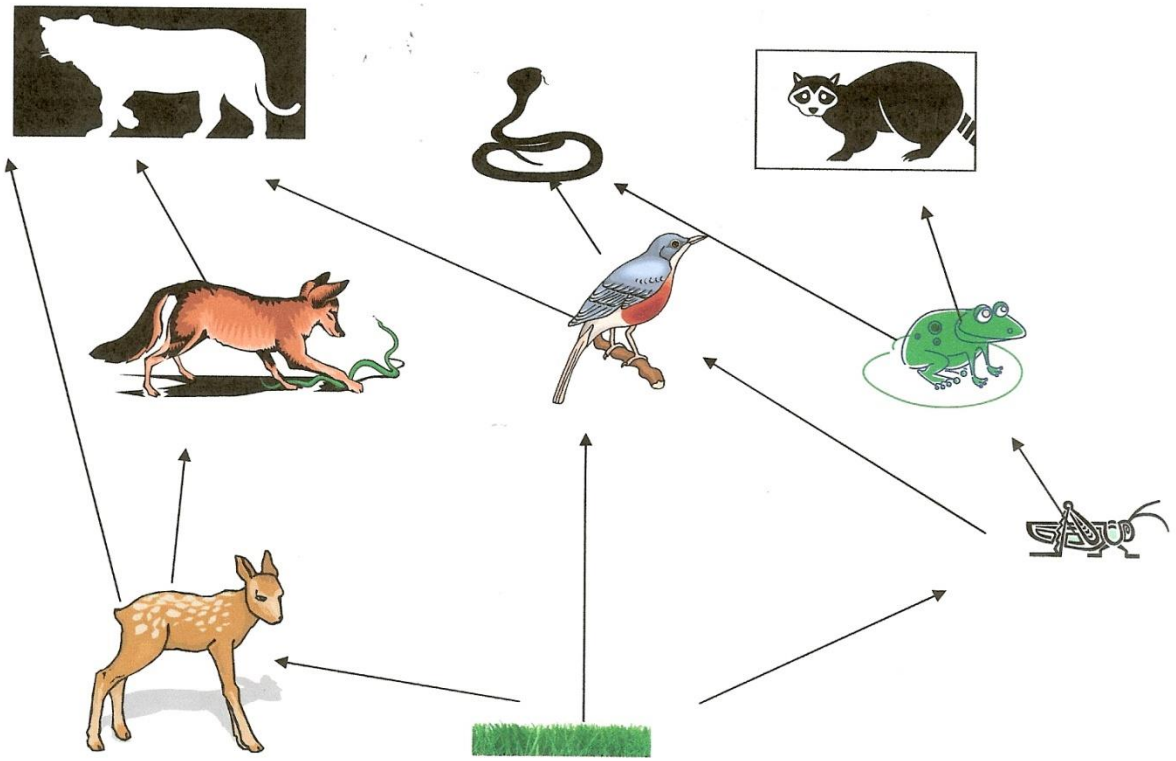


Nutrients get recycled but ENERGY IS ALWAYS LOST

- Each organism uses up energy → less energy as you move along the food chain

- *Practice food chain questions in your notes*

Food web shows lots of relationships between organisms



Food webs are more stable than single food chains

- Why???
- More diversity

Biodiversity

- Biodiversity =
  -
  - High biodiversity =
  - Low biodiversity =
- Diversity →
- Why????

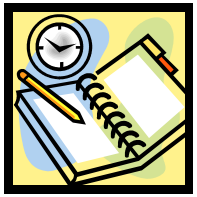
Niche

- Niche =
  - Ex: decomposer niche =
  - Producer niche =
  - Earth worm niche =
  - Wolf niche =

Competition

- Competition =
  - Ex: owl and raven fighting for fish in a lake
- If organisms occupy the same niche in the same habitat →
- If organisms live in the same habitat but occupy different niche

Summing up



Vocabulary

- Prokaryotes,
- producers,
- autotrophs,
- consumers,
- heterotrophs.
- decomposers,
- herbivores,
- carnivores,
- omnivores

Skills and Key Ideas

- Skills: drawing food chains and energy pyramids
- Key idea: first living things to appear on the planet were most likely single celled without a nucleus.
- Energy is lost as you move up the food chain

Habitable Worlds

- As a prisoner of DarthVader, Imperials forced Princess Leia to witness the destruction of her home planet of Alderaan.

- Brainstorm:
- If forced to find a new planet for your people to live on – what would you look for.
- What makes a good environment for life?
- List the 3 most important abiotic factors necessary for life as we know it.

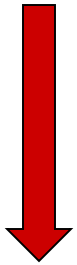
NOTES

Living Things Require:

1. Liquid Water
2. Raw Materials
   - (note: living things are made mostly of CHNOPS)
3. An Energy Source

NOTES

Matter and Energy



Life

The world as we know it starts as a large cloud of gas and dust

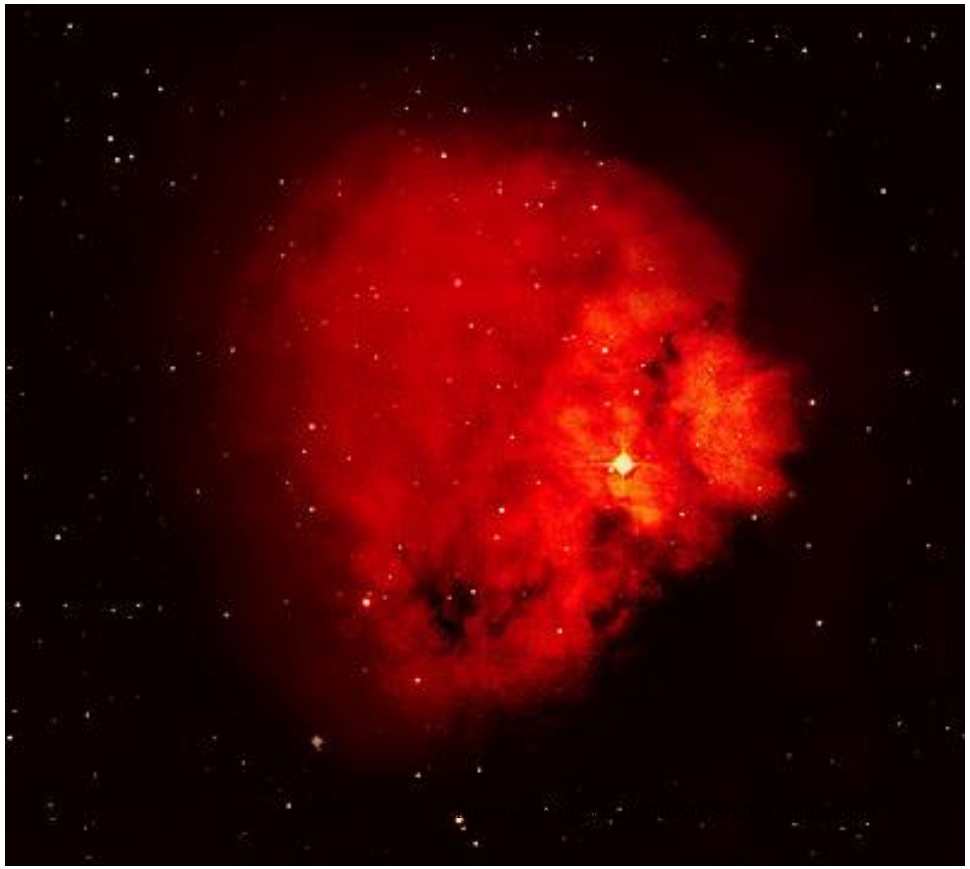
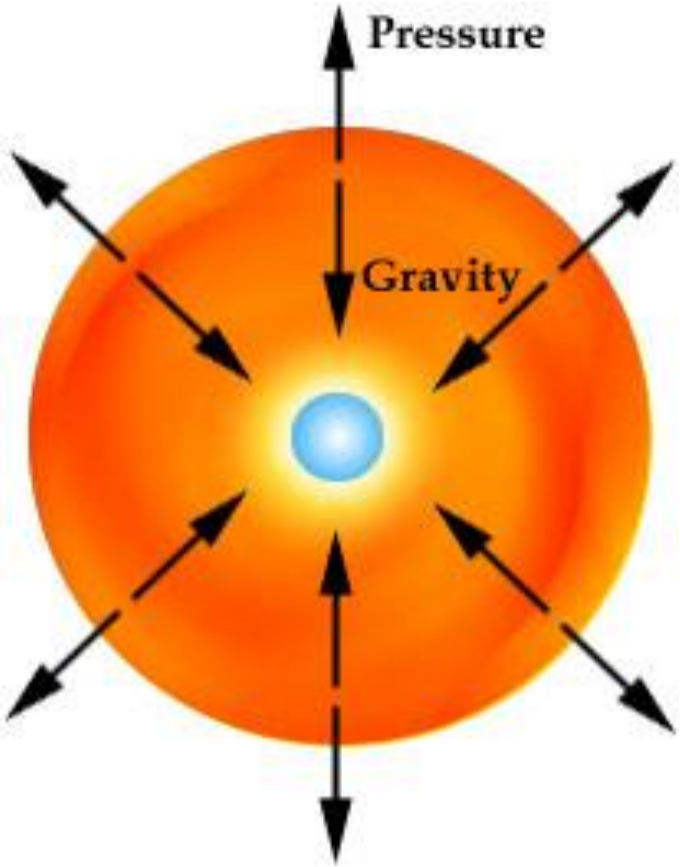
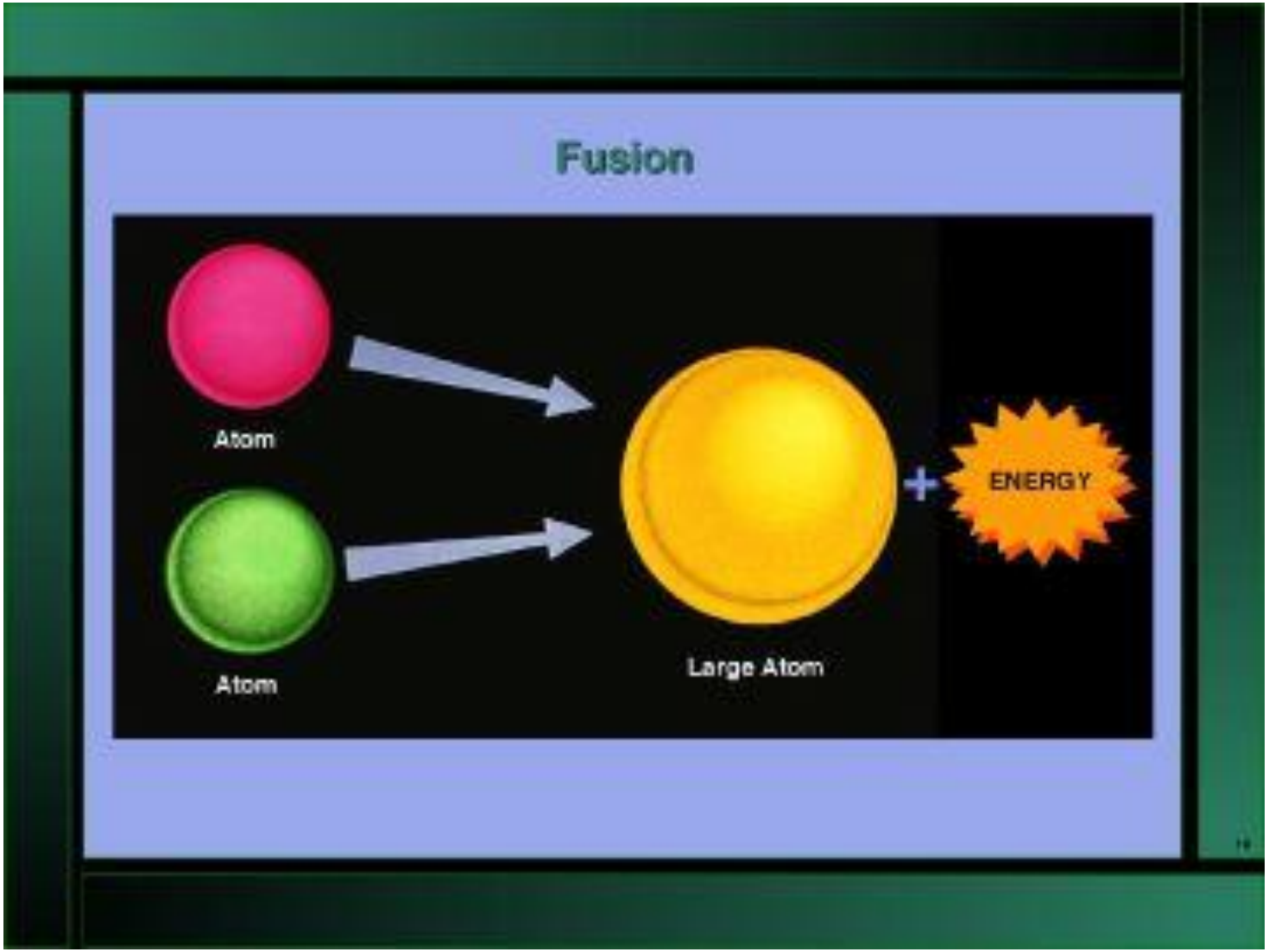


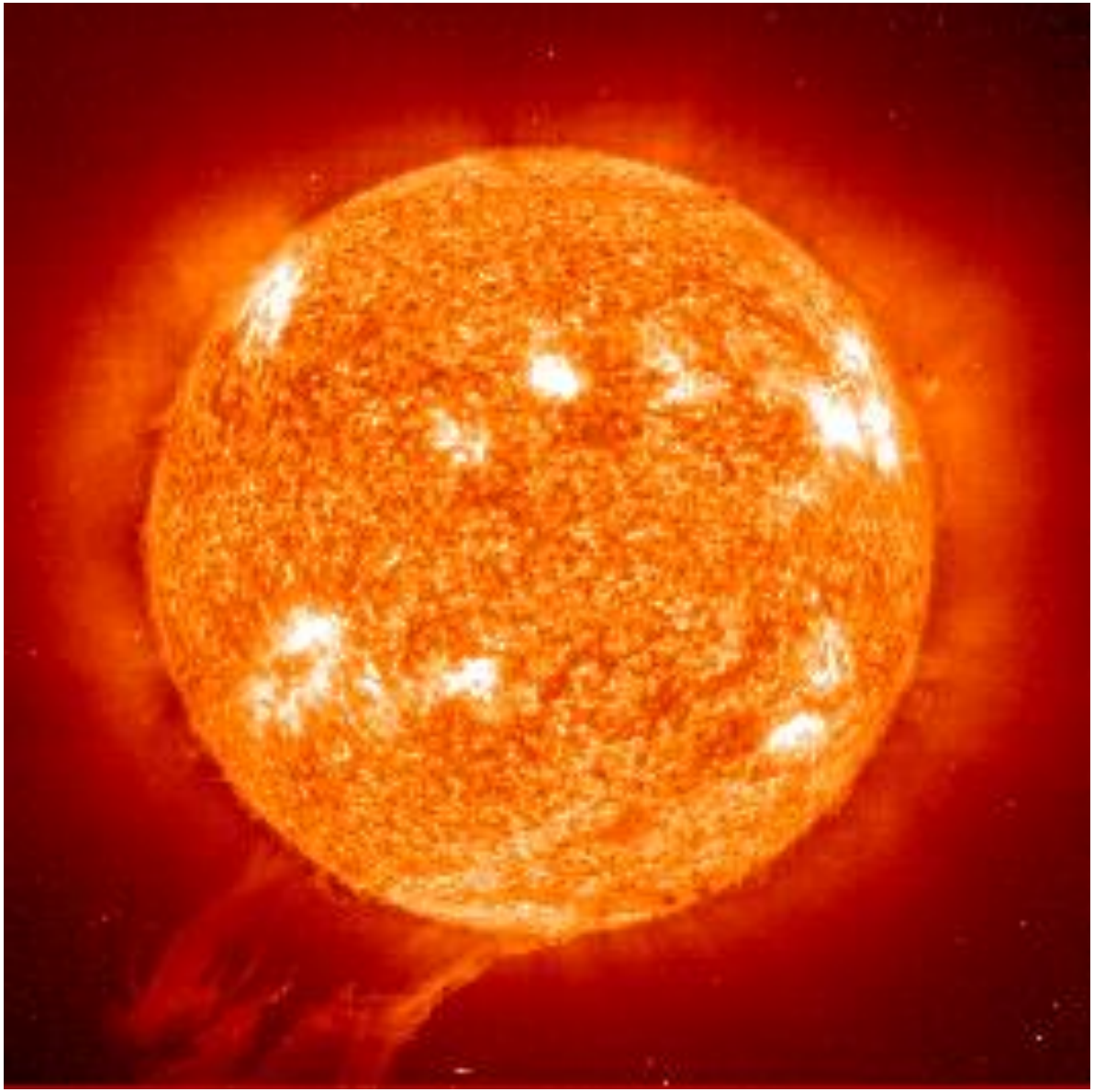
Figure 6. Sh2-242 is a small HII Region on the edge of a molecular cloud that lies just southeast of the supernova remnant Simeis 147 in the constellation of Taurus. There is evidence that this molecular cloud may contain a young stellar cluster of newly-born stars. The Isaac NewtonTelescope Group.

A star is born when gravity pulls molecules so close they begin to fuse

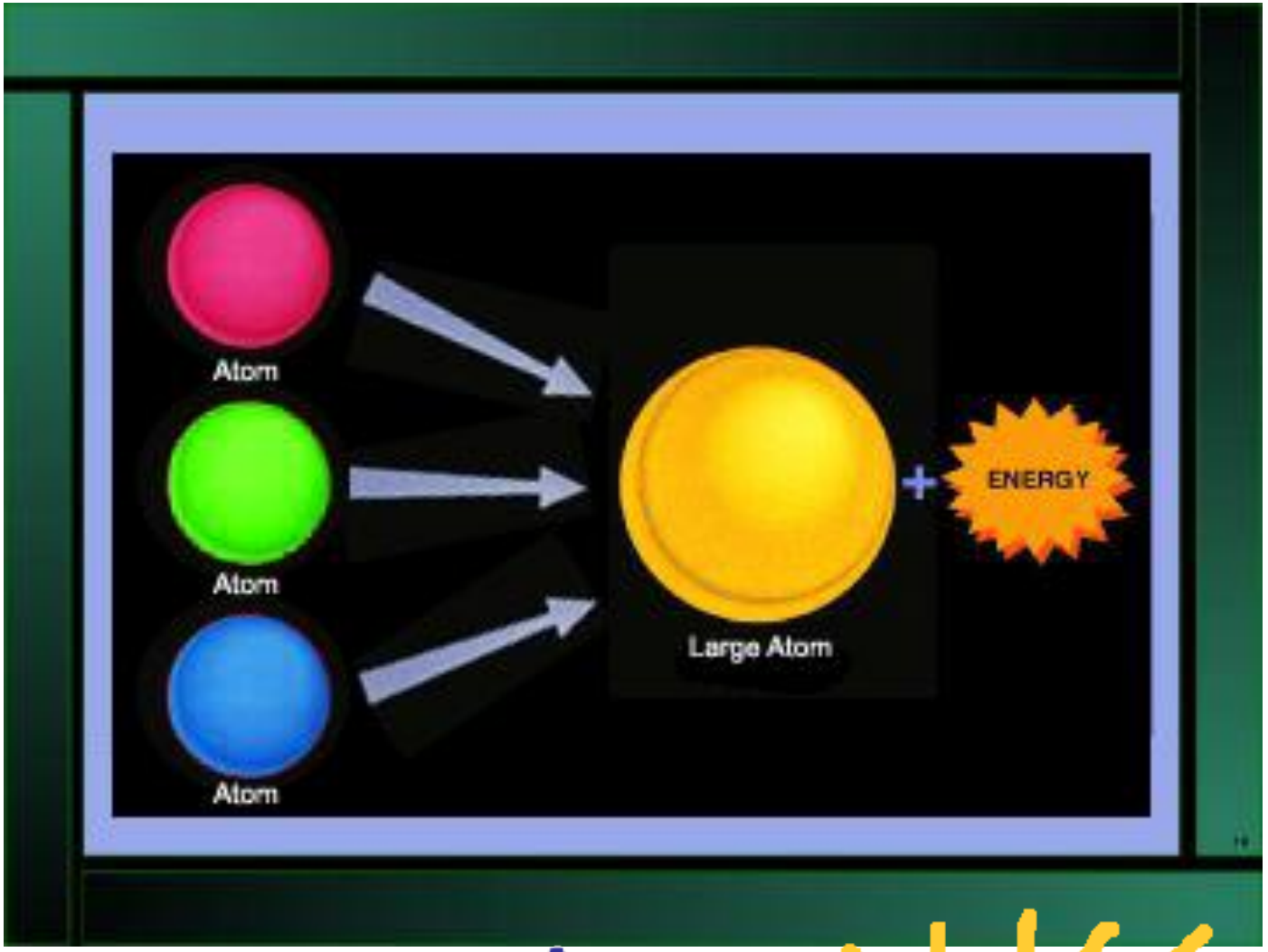




$$2H \rightarrow He + energy$$

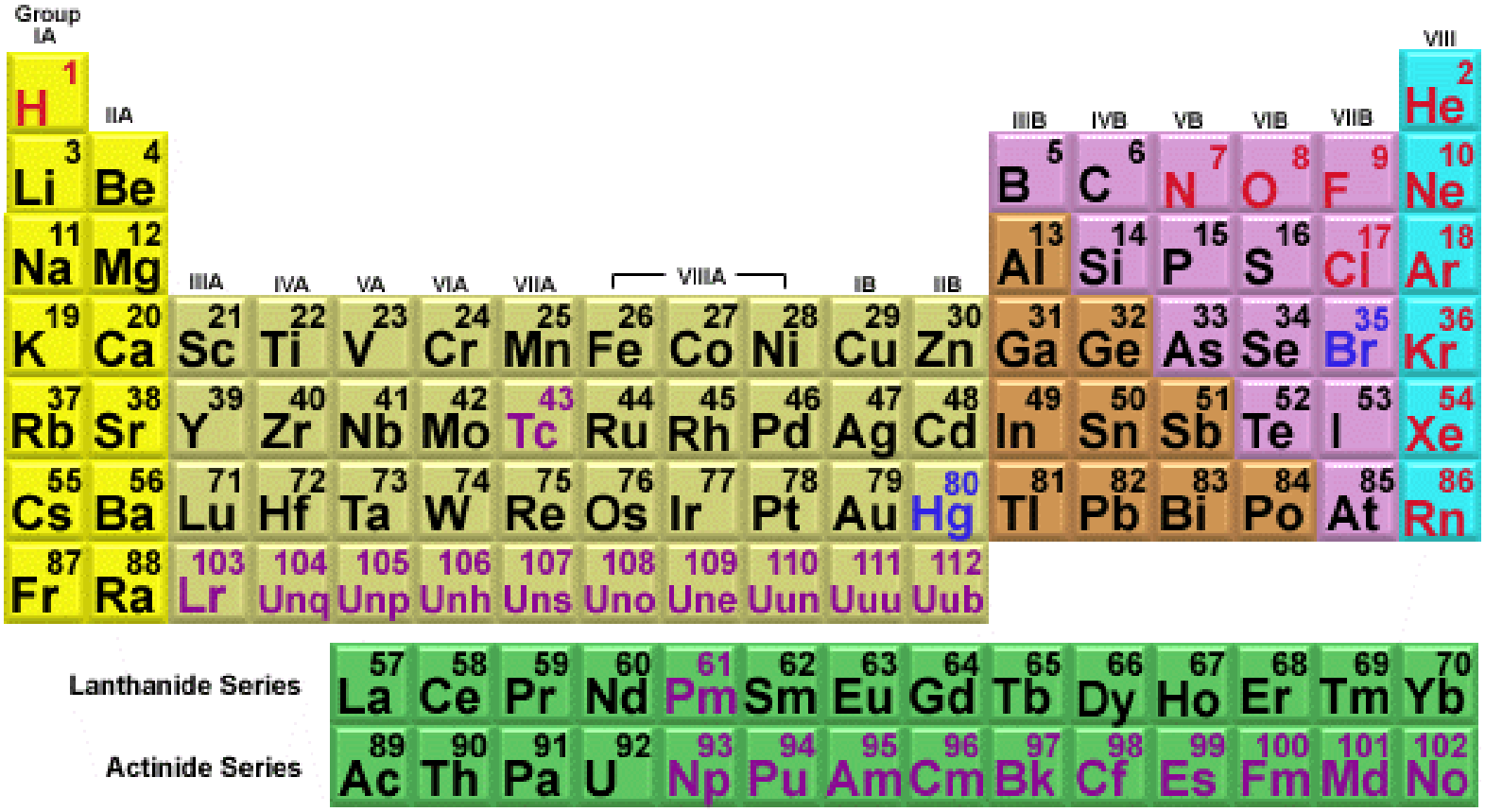


http://antwrp.gsfc.nasa.gov/apod/image/9906/solstice_erupt_big.gif

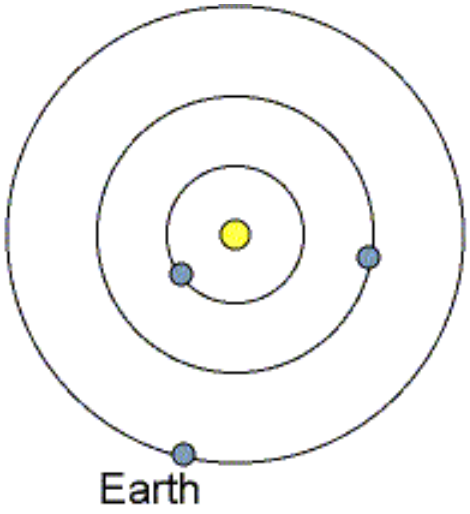


$$3He \rightarrow C + energy$$

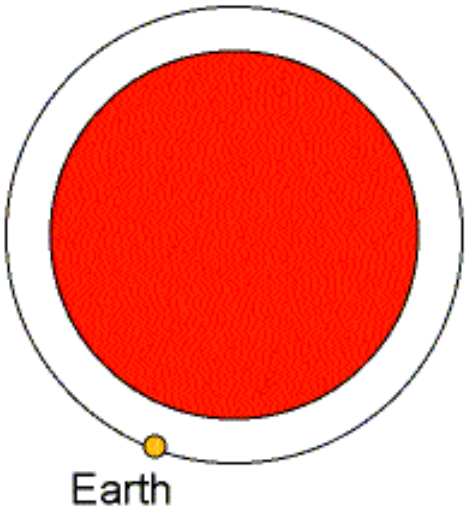
Fusion reactions within stars → all of the elements up to iron



Eventually stars (including our sun) will run out of fuel



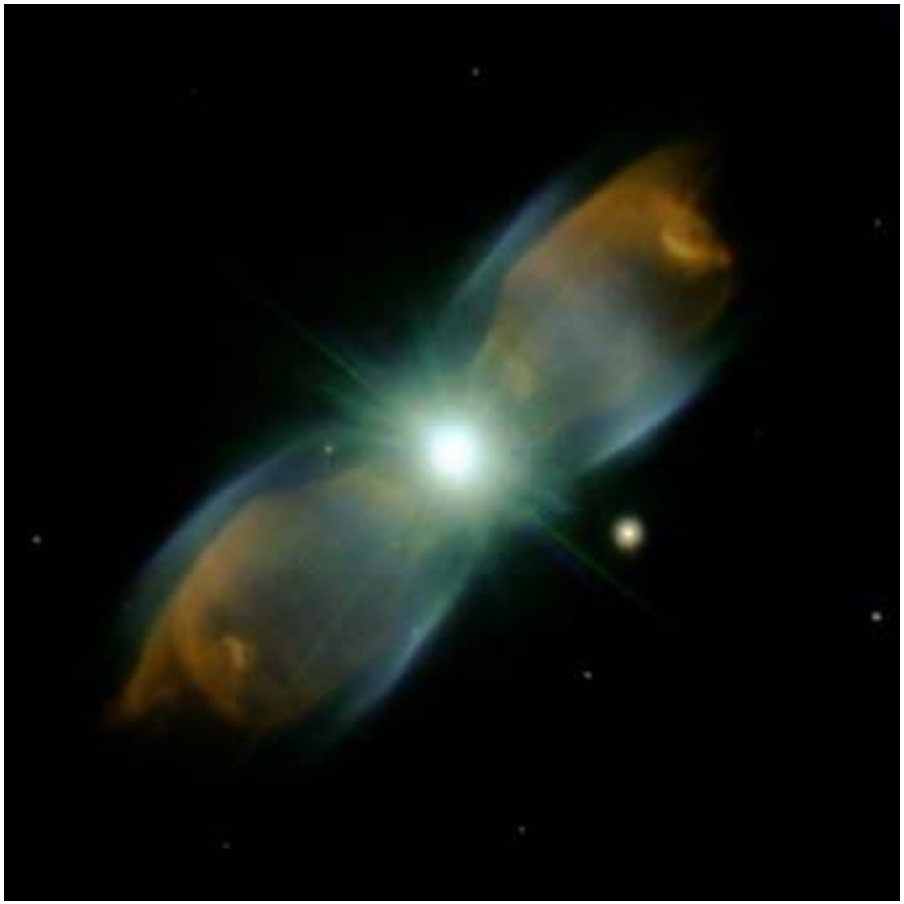
Now: hot core + warm surface; small size.



Future: very hot core + cool surface. Large size but less mass; very bright.

- 6.5 billion years from now

They explode with a massive amount of energy → heavier elements like silver and gold

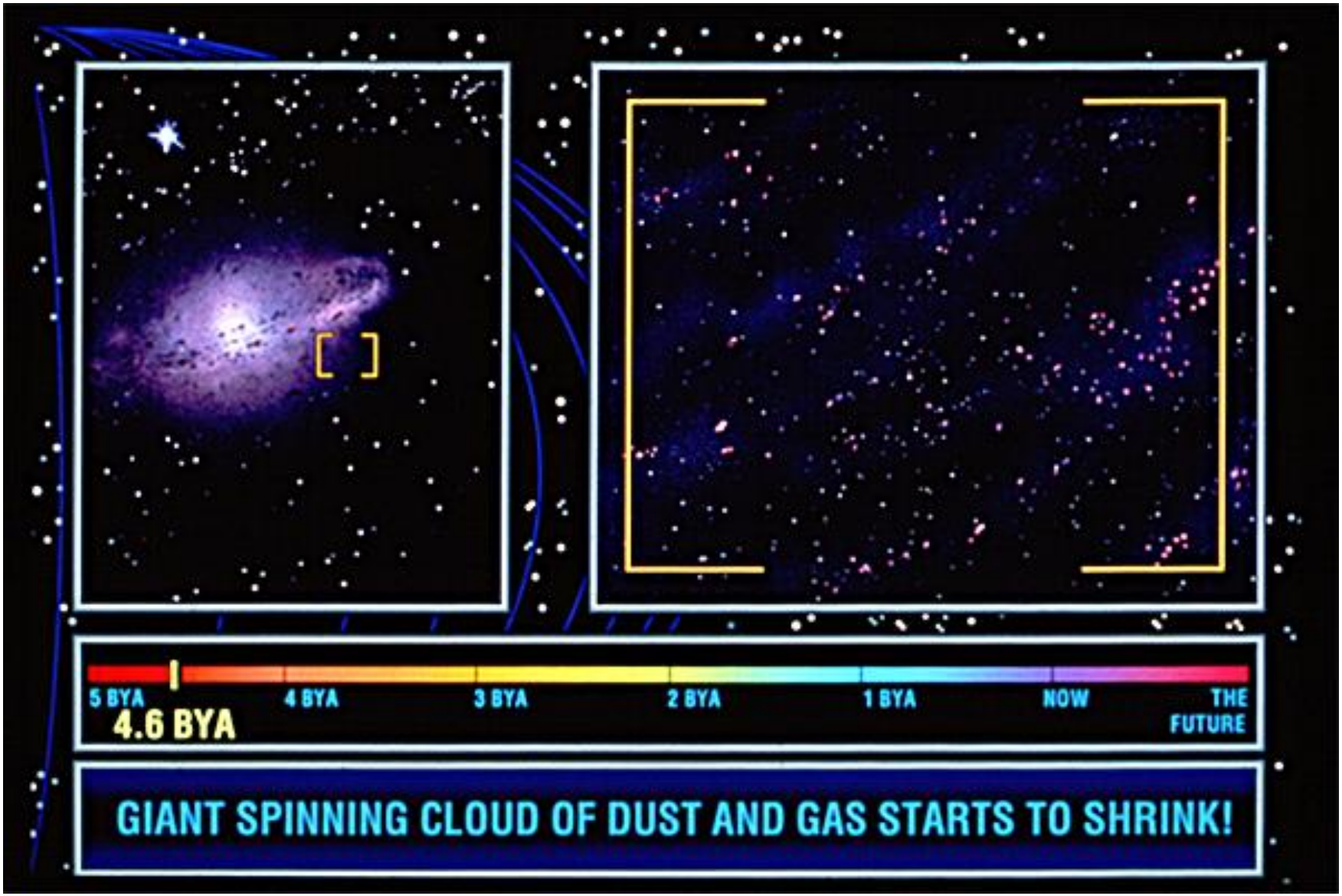


What does this mean?

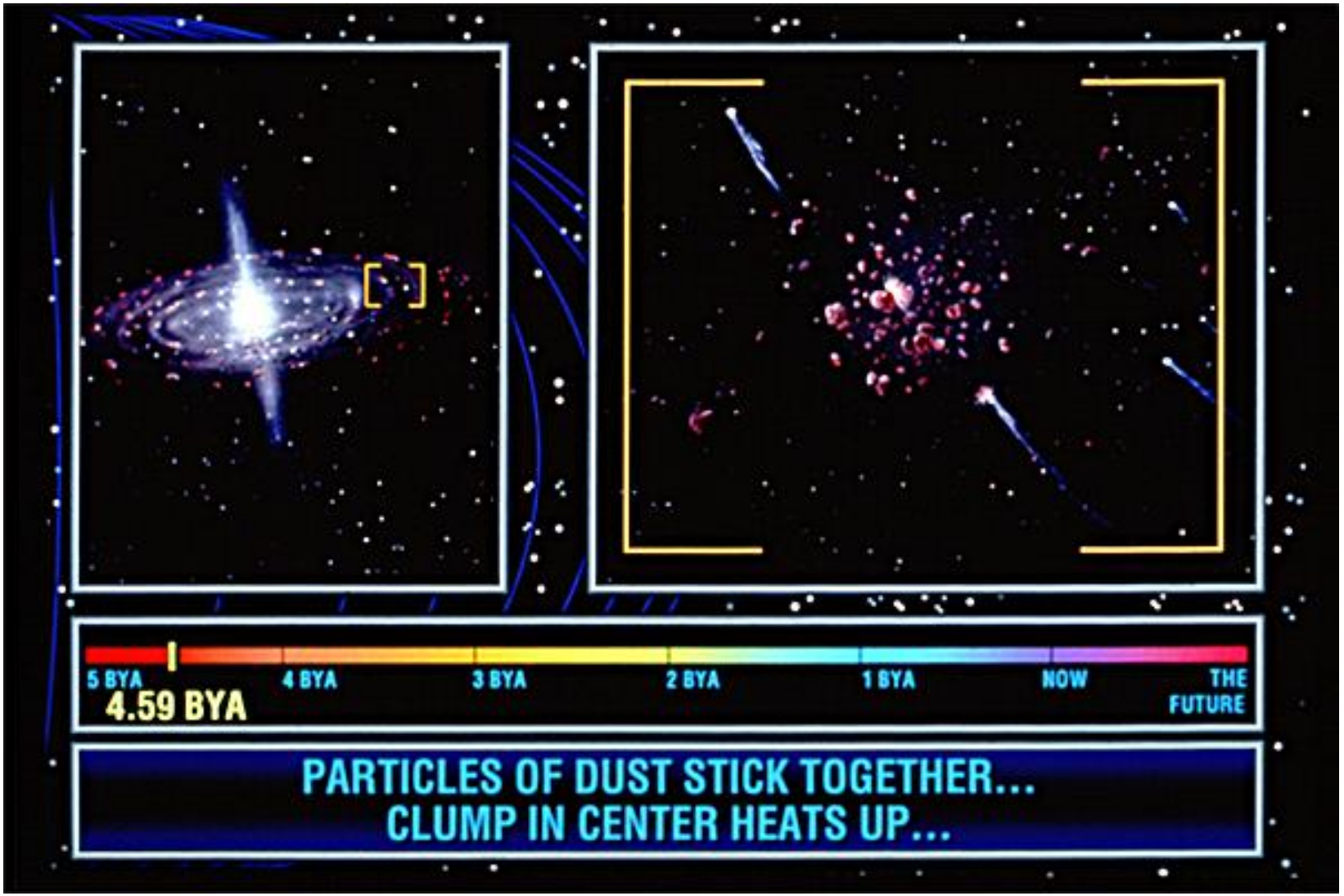
The gold in your necklace comes from star dust

You are made of elements made within stars

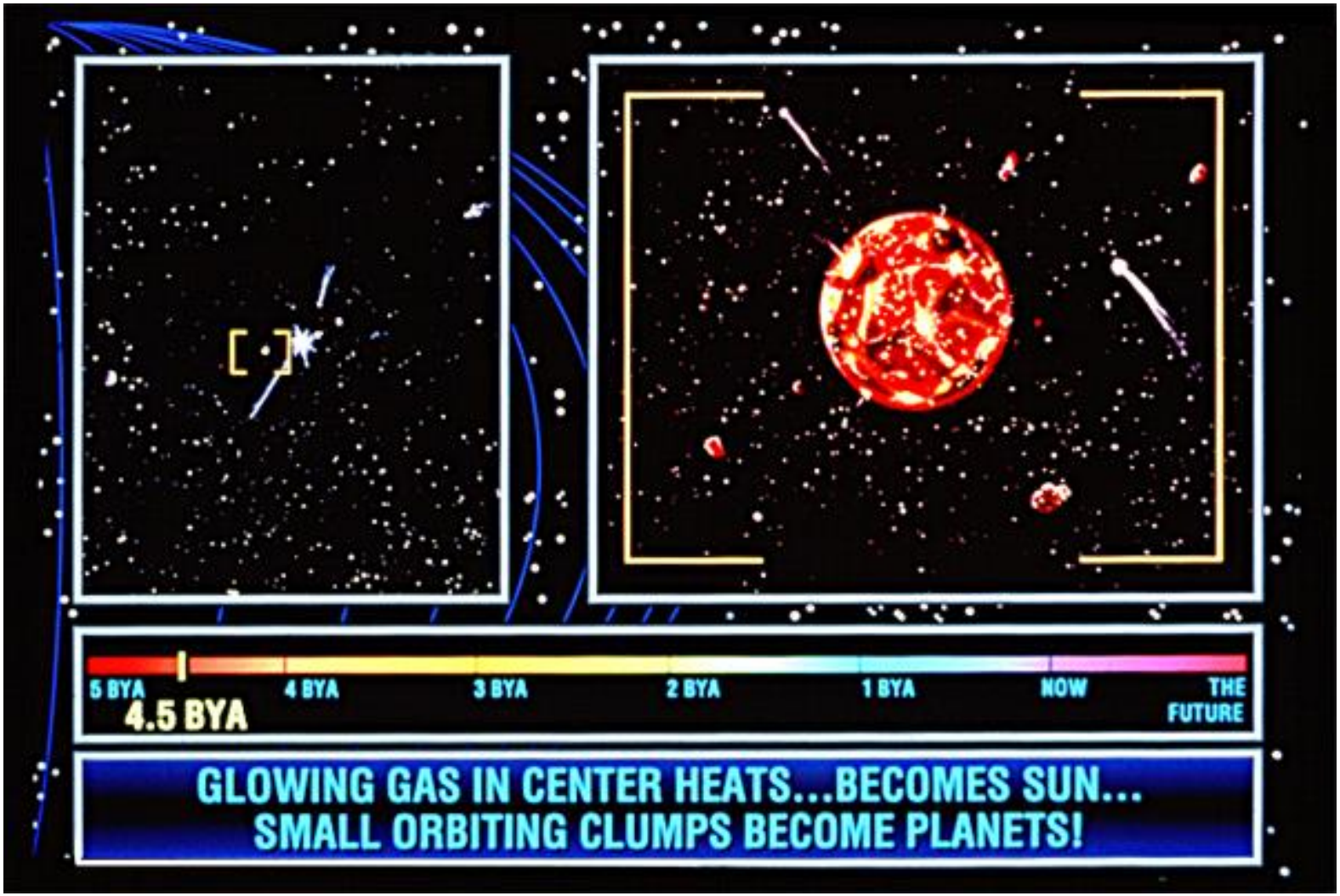
Origin of Our Solar System



Gravity pulls particles together

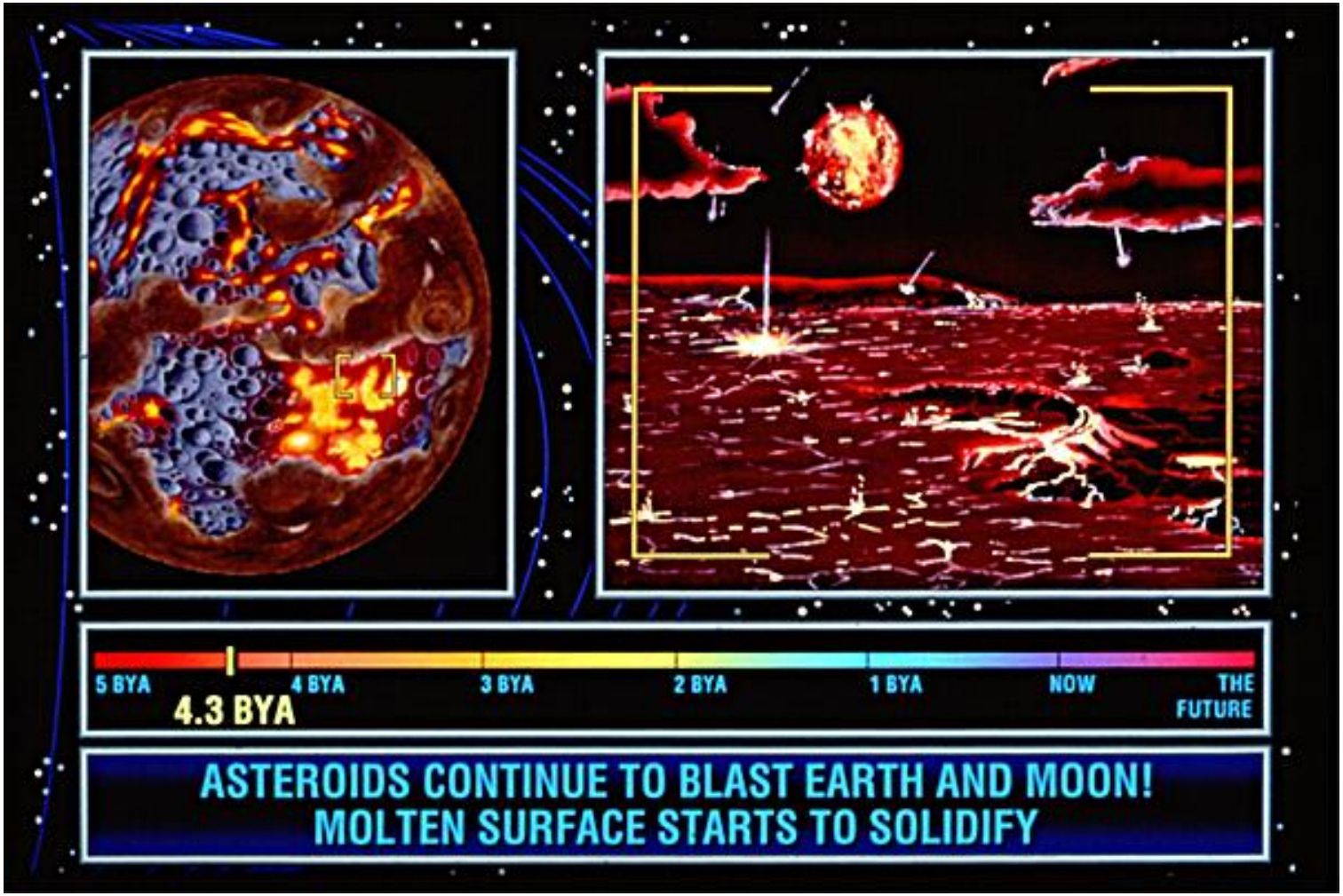


Sun and Planets are Born

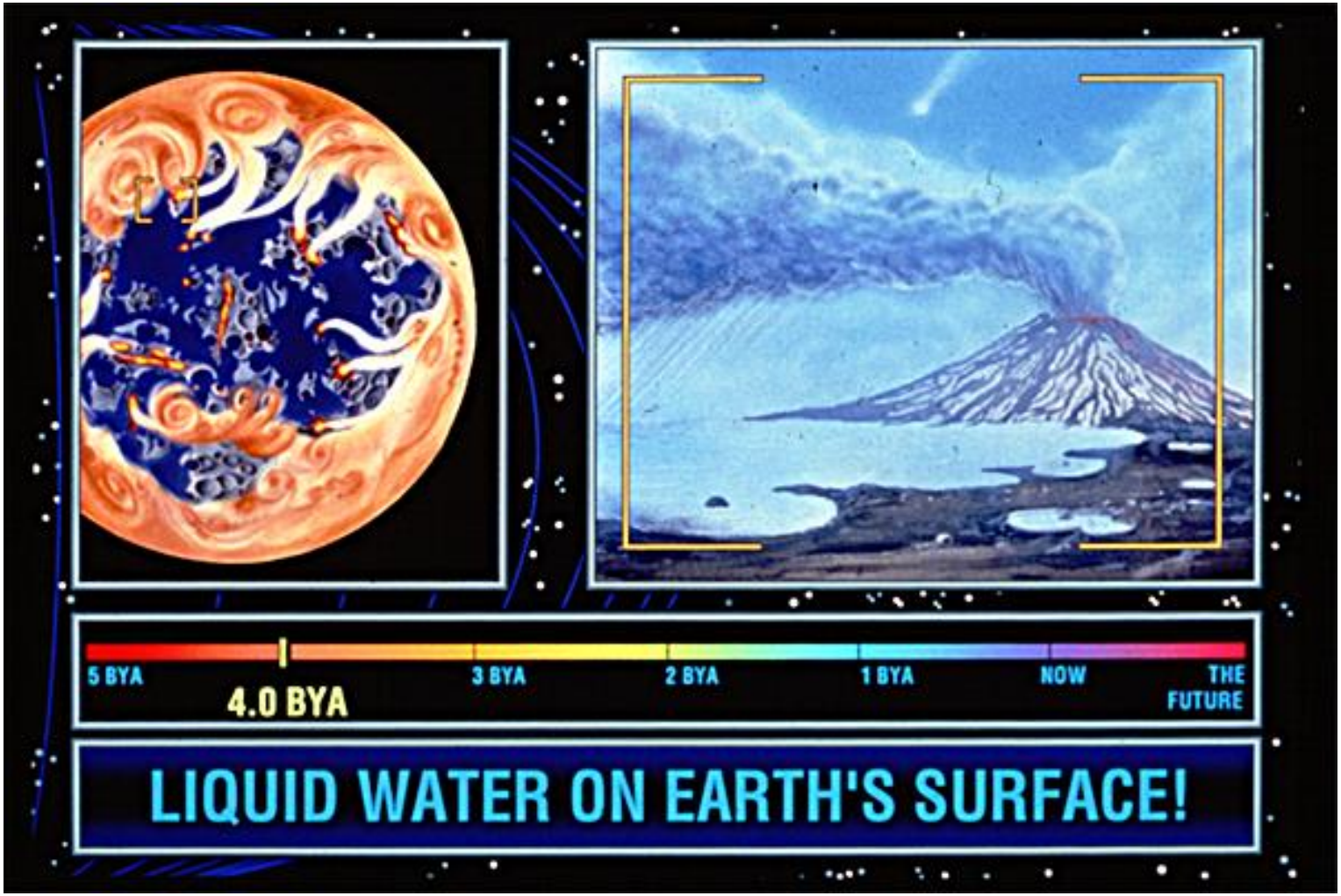


NOTES

Earth ~ 4.3 billion years old

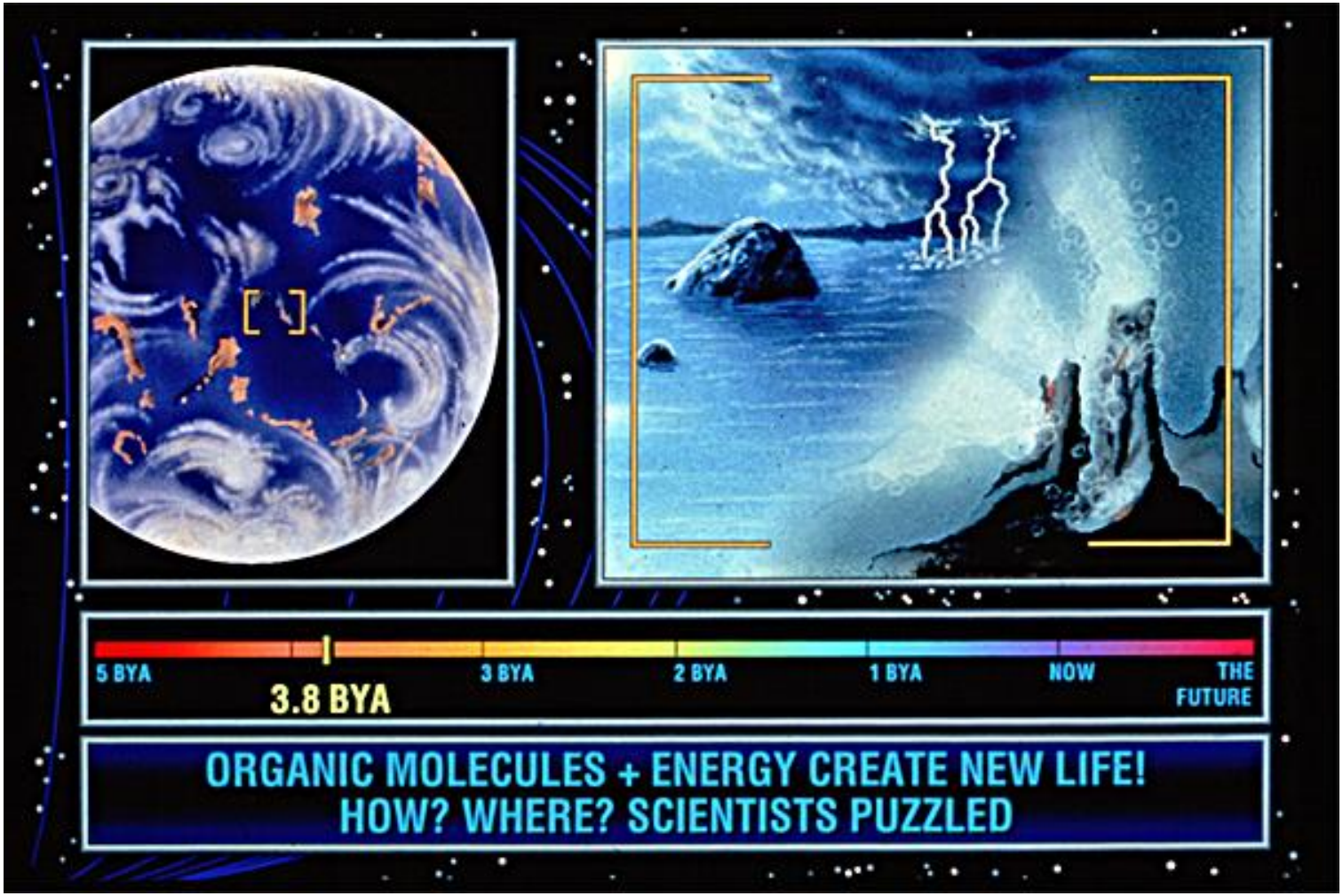


Things start to Cool Down



NOTES

Life??? ~ 3.8 billion years ago



NOTES

Abiotic = nonliving

Matter and energy

Biotic = living

NOTES

Living Things Require:

1. An Energy Source
2. Liquid Water
3. Raw Materials
   - (note: living things are made mostly of CHNOPS)

NOTES

Energy Sources for Life

- Solar
- Chemical
  - Organic (carbon based (has C and H))
  - Inorganic (Ex: forms of sulfur and iron)

NOTES

Liquid Water

- Dissolves and moves things
- Helps maintain balances (homeostasis)
  - Balances temperature
  - Balances concentrations of dissolved things

NOTES

Raw materials = Nutrients

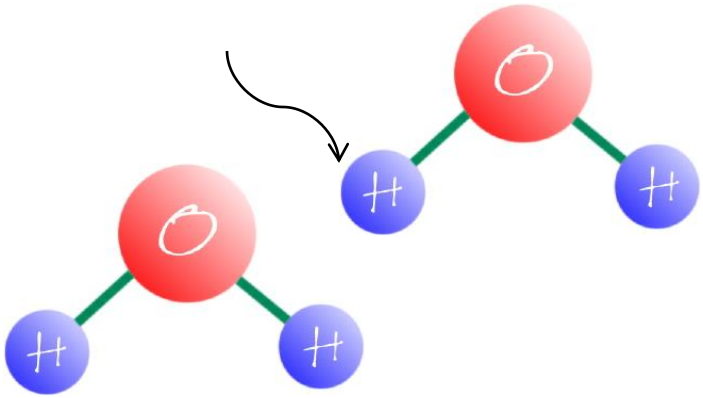
- Living things are made up of CHNOPS = 6 most important elements of life

Symbol	element	# protons
C =	Carbon =	6
H =	Hydrogen =	1
N =	Nitrogen =	7
O =	Oxygen =	8
P =	Phosphorus =	15
S =	Sulfur =	16

NOTES

Chemical Bonds
(Hold atoms together)

- Chemical bonds contain energy
- 3 types
  - Ionic = weak
  - Covalent = strong (holds the sugar phosphate backbone of DNA together)
  - Hydrogen = temporary (hold water molecules together)



NOTES

Compounds

- 2 or more atoms chemically bound together
- 2 types
  - Organic (ex: $C_6H_{12}O_6$ has both C and H in it)
  - Inorganic (ex: H_2O, O_2, CO_2)
  - Living things are made up of both

http://members.aol.com/profchm/chmjugl2.gif

NOTES

4 types of Organic Compounds necessary for life

- Carbohydrates (sugars)
- Proteins
- Lipids (fats)
- Nucleic acids (DNA and RNA)

Organic compounds = stored energy

- Carbon containing molecules have a lot of chemical bonds
- Chemical bonds = energy
- Break down organic compounds → release energy
  - Combustion → energy
  - Chemical digestion → energy

Post-assessment Quiz

- What is the difference between biotic and abiotic?
- What are living things made of?
- What are the 3 things that all life depends on?
- State the difference between organic and inorganic molecules